POWER

*Volume* 56 New York, December 5, 1922 *Number* 23

# Handwork and Headwork

A YOUNG man is cleaning and shining up a machine. He knows what will take the sludge off of one part and the burnt oil off of another and how to get the best shine on the glistening bright work —but his thoughts never go beyond the surfaces that he is working on.

Another, as he works to improve the appearance of the machine, wonders about the use and purpose of the things that he is working upon. What is this connection for? Where does the pipe that comes out of it lead to and what does it carry? What would happen if it leaked or burst? What is this system of levers for, what does it operate and how does it do it? What kind of a valve does this cam work and how is it adjusted? What does it look like inside of that cover?

He may not make so good a job of shining as the other fellow and he may be longer about it, but he will not be a shiner all his life.

Such a man has the habit of observation, of interest, of wanting to know. And wanting to know, he learns, and knowing, he becomes of more use to himself and to the world and to somebody who will pay him money for it.

Thousands of men have shoveled millions of tons of coal and lived in tenements all their lives. Comparatively few men have wondered what coal is anyhow, why it burns, what the process of burning is and how it can be perfected, and they have risen to positions of authority over the mere shovelers, have become combustion engineers or have invented processes and apparatus that have put them beyond the necessity of manual labor.

And they did not have to be college graduates to do it. Anybody who can read a daily paper and do problems in ordinary arithmetic, can do it if he is curious and interested enough.

It all depends upon what is going on in one's head while he is working with his hands.

F. R. Low

NEW powdered-coal plant of Eline's, Inc., Milwaukee, contains complete fuel-preparation plant. Special ventilation of furnace walls. Economizers installed and hot-process water-softening system. An outstanding feature is the co-ordination of the power and heating loads by connection of jet condensers and hot-water exhaust-steam heater.

# Modern Industrial Plant Burns Pulverized Coal

FOR years Milwaukee has been a leading industrial center famed countrywide for a number of its products. It is about to add another item to the growing list, and this time it is chocolate—chocolate in the solid form, and cocoa, to be made in the enormous new plant of Eline's, Incorporated, situated in North Milwaukee, about five miles north of the business center of the city and near the river to insure an abundant water supply. The works will be self-contained, as it is equipped to refine the sugar and pump all water needed from quarry holes spring fed, has its own box factory and printing department, and with a power plant burning powdered coal as fuel, will supply all services such as power and light, refrigeration, steam for process work and heating by hot water

The initial installation of factory buildings contains over 400,000 sq.ft. of floor area, the buildings being mostly five-story, of flat-slab concrete construction with an abundance of glass area. In addition there is a machine shop 57x160 ft., a garage 60x200 ft., a clubhouse and cafeteria 40x200 ft., and a 55x275-ft. two-story-and-basement administration building of Georgian architecture with distinctive interior fittings and decorations of harmonious and pleasing design. The connected electric load for power and lighting approximates 4,000 hp., the refrigerating capacity is 400 tons, equivalent direct radiation in the heating and air-tempering systems aggregates 110,000 sq.ft., and water from the initial source may be pumped at the rate of 12,000 gal. per minute.

To furnish these various services, a privately owned plant was considered essential and it was decided to equip it for the burning of powdered coal. For an ultimate installation of six boilers, each containing 5,000 sq.ft. of steam-making surface, it was recognized that the cost per unit would be greater than for a modern stoker plant, but it was anticipated that the higher economies possible, maintained uniformly, would more than offset the interest charges on the additional investment and give more flexible operation.

Unfortunately, at the present writing no test figures are available nor are there operating data that would serve to indicate the economies, as the works has not as yet settled to normal operation. However, the plant has been running for a year and the boiler units required to carry the load have been operated at 150 to 200 per cent of nominal rating. Arches and furnace brickwork show no evidence of deterioration, and as no serious troubles have developed, general satisfaction is expressed with the plant as a whole and particularly with the ease and flexibility of operation.

The power plant is of brick and steel construction, measuring in plan 150x160 ft., with a large percentage of glass area in the walls to insure a light and well-ventilated interior. Between boiler and engine rooms there is no dividing wall. Economizers at the rear of the boilers, resting on a brick foundation containing the smoke flue, afford sufficient separation between these two departments of the plant and at the same time give ready access from one to the other. The dutch-oven

furnace fronts in which the burners are mounted, are in near proximity to the dividing wall isolating the fuel-preparation room from the rest of the plant. In the aisle thus formed underneath the bunkers, the fans and all controls for the admission of air and fuel to the furnaces are located.

Boilers of the vertical, water-tube type were selected. Four of these, each containing 5,000 sq.ft. of steam-making surface, have been installed and there is space for two more of the same size. For the latter the foundations have been provided and the boilers themselves are going in at an early date. The fuel-preparation plant was designed with sufficient capacity for the entire six boilers. Fig. 5 indicates that these boilers are mounted on concrete foundations in batteries of two. The gases of combustion are discharged into a brick smoke flue near the bottom of the boilers, and the masonry is continued upward to form a support for the cast-iron economizers that will serve each battery of two boilers. At present only one economizer is installed, but another is to go in shortly and the third will be put in place with the two additional boilers that are to complete the plant. With 322 tubes 12 ft. long, the economizer surface aggregates 524 sq.ft. The flue connections are so arranged that the gases from any four of the present boilers may pass through the economizer or, if desired, directly to the stack. Sufficient draft to pull the gases through the economizer is supplied by a brick stack 250 ft. high above the boiler-room floor and 12 ft. in diameter at the top. The stack is lined for 125 ft. and for artistic effect has an ornamental head of original design with 20 ft. of stack above, finished with white glazed brick.

The boilers operate at 175 lb. pressure and approximately 100 deg. of superheat. The superheater header is outside the boiler casing and the main steam header is arranged between the economizer support and the boilers, as indicated in Fig. 5.

Double furnaces, with a division wall between, serve each battery of boilers, although in operation each furnace and its burner equipment make up a distinct unit, as there is no interconnection between them. The side walls are heavily reinforced by steel members, as indicated in Fig. 5, while the center wall and also the bridge wall are protected against destructive temperatures by ventilation. For the first ten feet of its height this center wall is 3 ft. 1½ in. thick and from this point upward a 2-ft. 7½-in. wall is provided.

For ventilation an air duct, 12x12 in., passes horizontally along the bottom of the center wall and joins a vertical duct rising between the brickwork of the bridge wall and the concrete foundations of the boilers. From the horizontal duct groups of 4-in. building tile on 36-in. centers lead vertically up through the center wall and discharge into the boiler room. Similarly, horizontal ducts lead from the central vertical riser to either side, to discharge into the boiler room at the side walls of the furnaces. The system thus provides for a constant circulation of air, drawn from the boiler-room basement and discharged into the boiler room, which should keep both the center wall and the bridge wall at comparatively low temperatures and prolong the life of the brickwork. Fig. 6 shows the arrangement of these ducts.

The furnaces have been designed to maintain the boilers in operation at 300 per cent of nominal rating. The width from center wall to side wall is 10 ft., the length from front wall to bridge wall 14 ft., and with a flat suspended arch for the roof, gradually rising as it approaches the boiler, the height varies from 25 ft. at the front wall to 30 ft. at the rear of the furnace. The volume of each furnace is approximately 3,500 cu.ft. Assuming 4,000 lb. of coal per hour is required to maintain operation at 300 per cent of rating, the furnace volume would reduce to 0.875 cu.ft. per pound of coal burned per hour.

### Air and Fuel to Furnace

At the present, Eastern bituminous coal containing about 12,000 B.t.u. per pound is the fuel used. Owing to the length of furnace available with the vertical boilers, horizontal burners were installed. Two 8-in. burners are provided for each boiler and placed 10 ft. above the bottom of the furnace. Below the burners 2 ft. 3 in. are peep-holes for observation of the flame and 2 ft. 9 in. farther down are circular air ports,

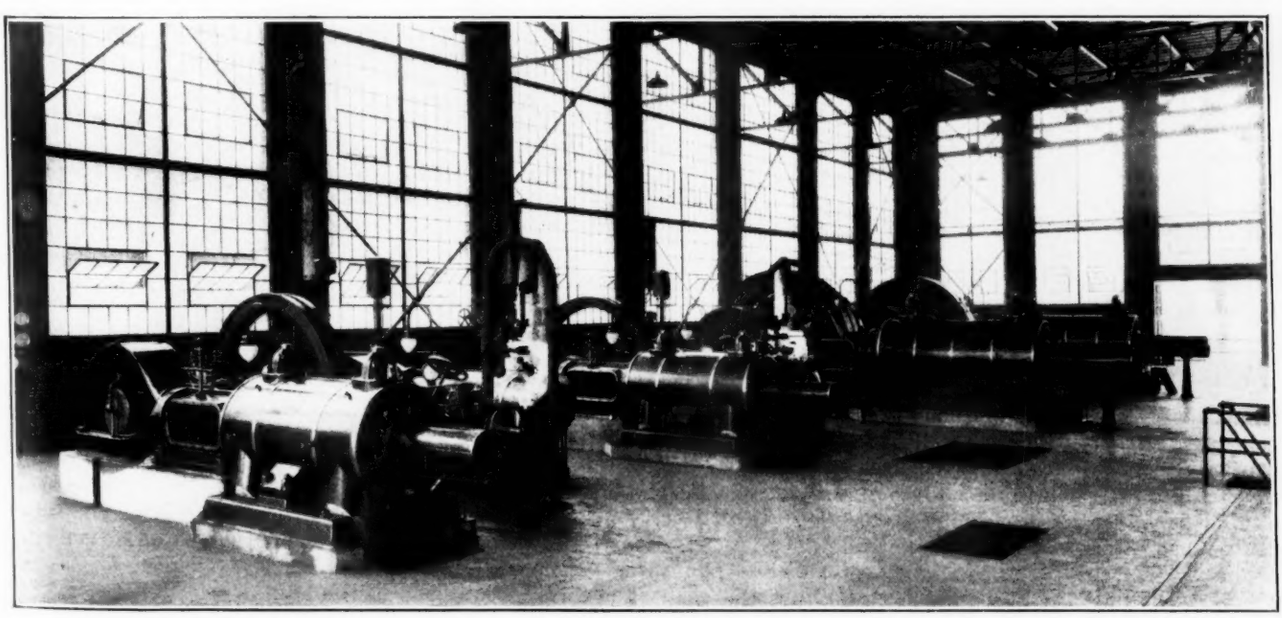


FIG. 1—AMMONIA COMPRESSORS, 200-TON, IN FOREGROUND AND 750-KW. GENERATING UNITS

three to the furnace, with butterfly dampers which may be opened or closed in unison from the boiler-room floor. At the bottom of the furnace are three clean-out doors having a chain connection to a common shaft driven through a miter gear from a handwheel on the operating floor. The air ports are provided to supply the additional air needed for combustion and to keep down the furnace temperature. For the same reason the bottom doors are opened when operating at high ratings. Air admitted through these doors reduces the temperature of the lower part of the furnace and tends to prevent the formation of slag.

From the individual bunker supplying each burner, the prepared coal is taken by a 5-in. screw feeder driven through a variable-speed transmission by a 2-hp. induction motor. From the end of the screw the fuel drops vertically downward through a 6-in. pipe leading to the burner and thence is carried into the furnace by the air blast joining the stream of coal at this point. The pressure used varies from 5 to 8 oz., depending on the capacity desired.

Air to each furnace is supplied by a down-draft fan driven by a 7½-hp. induction motor making 1,800 r.p.m. The fan draws the air from the boiler room and discharges into a common duct underneath the operating floor, from which the air is supplied to the burners at the pressures previously indicated. A certain quantity of induced air enters the furnace through the annular openings around the burners, and as previously stated, additional excess air is drawn in through the circular ports and the clean-out doors at the bottom of the furnace.

Any accumulation of ash in the boiler furnaces is removed through the clean-out doors and transferred into a vacuum ash-removal system discharging into a steel tank within the boiler room. The discharge chute from the tank passes through the wall and overhangs the railway siding for delivery into railway cars. By the same system the economizer soot is removed from a steel hopper placed below the economizer.

## Fuel Preparation

In pointing out the features of the coal-preparation plant, the simpler way will be to trace the coal from the railway car to the bunkers in the boiler room. For immediate preparation the coal is dumped from the car into a track hopper. A plate feeder delivers the coal to a magnetic separating belt conveyor unit which removes the scrap iron and discharges the coal into a single-roll crusher having a capacity of 25 tons per hour. The alternative is to unload the coal into yard storage back of the plant, where there is ample space for a large reserve supply, although at present the limitations are 75 by 300 ft. and a storage of 10,000 tons. The transfer from car to storage is effected by a 75-ft. gantry crane of simple and light design, equipped with a 1-cu.yd. bucket electrically operated.

From the storage yard the coal is reclaimed into a steel hopper secured to the supporting members of the crane. It is discharged onto an 18-in. belt conveyor and delivered over a magnetic head pulley into a grizzly which allows the fine coal to go directly into a bucket elevator and the coarser coal into the crusher, which also delivers into the same bucket elevator. The latter has a capacity to elevate 30 tons of coal an hour into the 40-ton green-coal storage bin in the preparation plant, which is equipped with a scale for weighing the coal. The bin has a hopper bottom to which is attached a cradle feeder that can be regulated to vary the quantity of coal going to the drier.

As shown in Fig. 3, the drier is of the indirect-fired rotary type using pulverized coal as fuel or the gases of combustion from the main breeching. The drier proper consists of a heavy iron shell 4 ft. 6 in. in diameter and 42 ft. long, revolving on rollers and driven through a speed reducer by a 7½-hp. induction motor. The shell inclines slightly toward the delivery end and is fitted with shelves arranged so that the coal is lifted and dropped across the interior through which the hot gases from the combustion chamber are passing. The speed of rotation ranges from 1 to 3 r.p.m., and owing to the pitch of the shell the coal passes forward gradually until it reaches the delivery end. With coal containing from 10 to 12 per cent moisture, the drier has capacity to reduce the moisture content in 10 tons of coal per hour to 2 or 3 per cent or less.

## Pulverizing Equipment

From the drier shell the dry coal is discharged into a hood from which it is spouted to the boot of a bucket elevator. The hot gases of combustion are drawn from the shell and discharged into a cyclone collector by means of a motor-driven exhaust fan. Any of the fine coal that may have been picked up and carried off owing to the velocity of the gases, is recovered in the cyclone and returned to the bucket elevator. From the cyclone the gases are passed through a spray chamber or scrubber and cleaned before being discharged to atmosphere.

From the bucket elevator previously mentioned, the dry coal is transferred into a 12-in. screw conveyor delivering into either one of two 14-ton steel bins serving the two 46-in. pulverizing mills shown in Fig. 4. These mills are of the fan discharge type. When operating on coal having a moisture content of 3 per cent, each machine is guaranteed to pulverize 4.6 tons of coal per hour to a fineness that will permit 95 per cent of the output passing through a 100-mesh screen and 85 per cent through a 200-mesh screen. Each mill has a silent chain drive from a 100-hp. induction motor having a speed of 900 r.p.m.

By means of a special feeder mounted on top of the mill the dried coal is transferred from the bin to the mill as needed. The feeder is driven from the mill shaft by means of a belt running on a pair of pulleys. An eccentric and link motion permits regulation of the feed. In addition a slide in the hopper of the feeder may be adjusted to vary the quantity of coal passing from the bin.

Upon leaving the feeder, the coal enters the pulverizing zone of the mill, consisting of four unattached steel balls rolling in a concave-shaped ring. In passing between the balls and the ring, the fuel is pulverized to the desired fineness.

Each mill is equipped with two fans—one operating in a separating chamber above the pulverizing zones and the other in the fan housing below the pulverizing zone. The former lifts the fine particles of pulverized coal into the separating chamber, where they are held in suspension and by the suction of the lower fan are drawn through a finishing screen surrounding the separating chamber into the lower fan housing and discharged into a cyclone located high up on the boiler room side of the wall. From the cyclone for either mill, delivery is made into a 9-in. screw conveyor which discharges the coal into any one of the 5-ton steel bunkers serving each burner. As there is a bunker for each burner

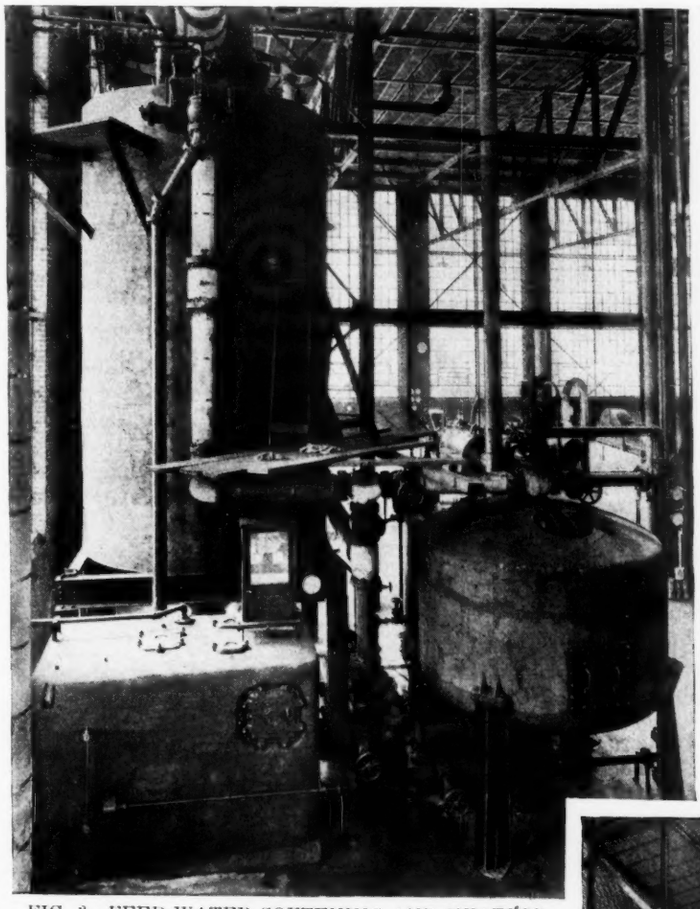


FIG. 2—FEED-WATER SOFTENING AND HEATING INSTALLATION

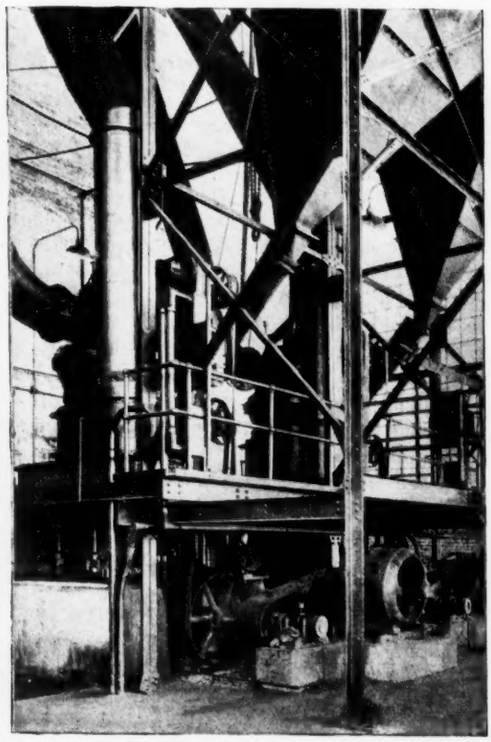


FIG. 4—THE TWO 46-IN. PULVERIZING MILLS OF THE FAN DISCHARGE TYPE

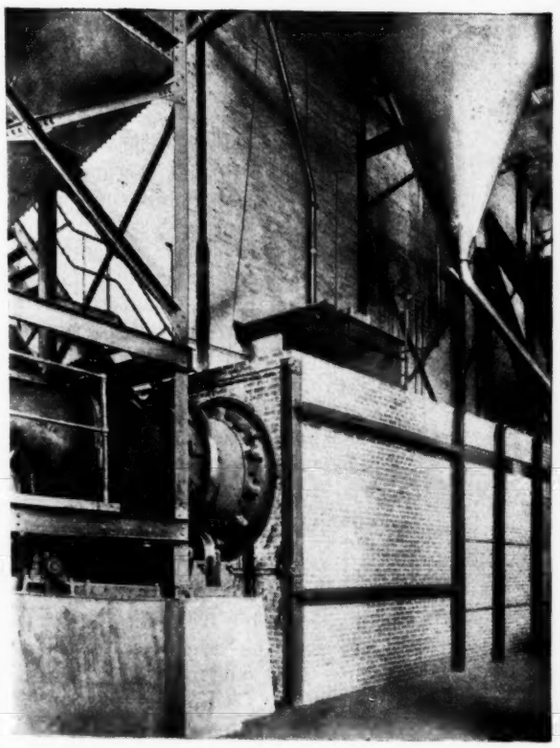


FIG. 3—INDIRECT FIRED ROTARY DRIER WITH CYCLONE SEPARATOR ABOVE

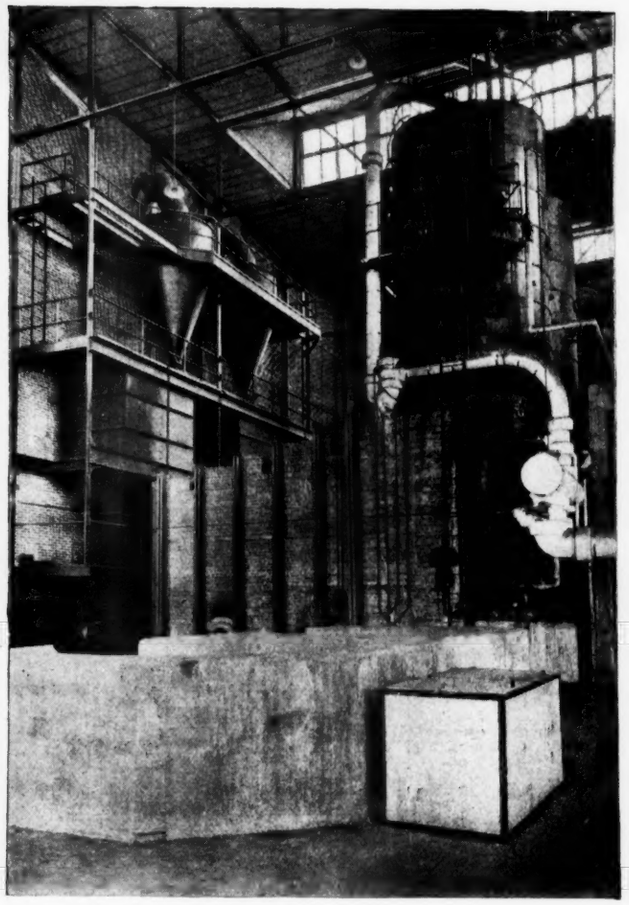


FIG. 5—BOILER INSTALLATION, SHOWING POWDERED COAL BUNKERS AT LEFT

and two burners to a furnace, the plant will eventually have a row of twelve of these small bunkers. At a certain point of the main screw conveyor, delivery is made to a second screw supplying a 3-ton storage tank for the drier furnace.

## The Water Supply

In a manufacturing establishment of the character under description, the water supply is of primary importance, as there are large uses for water in the industrial processes, for fire purposes and for use in the power plant. In locating the plant this detail was given full consideration. About 2,000 ft. from the power house is a lake some 400 ft. wide, 4,000 ft. long and 14 ft. deep fed by springs and the Milwaukee River. At the end of this lake a concrete pumping station was erected containing two motor-driven pumps, each having a capacity of 6,000 gal. per min. and driven by a 150-hp. induction motor of the squirrel-cage type. The pumps were set below the water line so that there is always sufficient head of water on the suction side to obviate priming. Remote control on the motors makes it possible to start and stop the pumps from the power house.

A 24-in. underground cast-iron water line connects the pumping station to a 300,000-gal. concrete reservoir adjacent to the power house. Through a strainer this reservoir has gravity communication with a cold well in the basement of the plant, the latter being the source of supply for the condensers and general power-plant service.

From the concrete reservoir water is pumped into underground fire mains and to a high-gravity 300,000-gal. tank by a centrifugal pump rated to deliver 3,000-gal. per min. and driven by a 200-hp. induction motor. A pressure controller starts and stops this pumping unit as the water level varies in the tank. From grade to the top of the tank, the head is 160 ft., so that a reserve supply is always available for general service throughout the works.

A well near the power house offers another source for water which is drawn upon to supply the lavatories, shower baths, manufacturing machinery and the domestic hot-water and drinking-water systems. This supply is made available through a separate system of piping. The water is pumped from the well into a second tank immediately below the high-gravity tank and supported on the same steel tower.

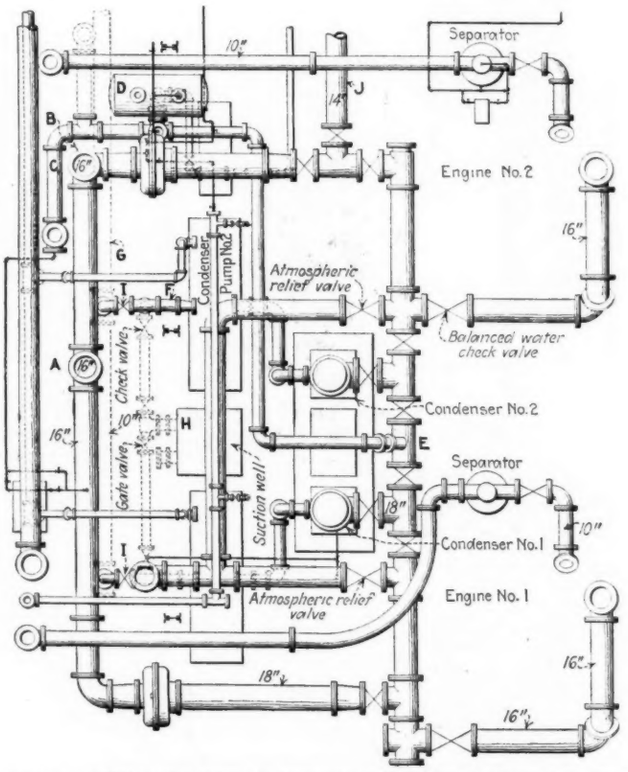



FIG. 7—EXHAUST STEAM PIPING CONNECTIONS BETWEEN CONDENSERS AND HOT-WATER HEATER

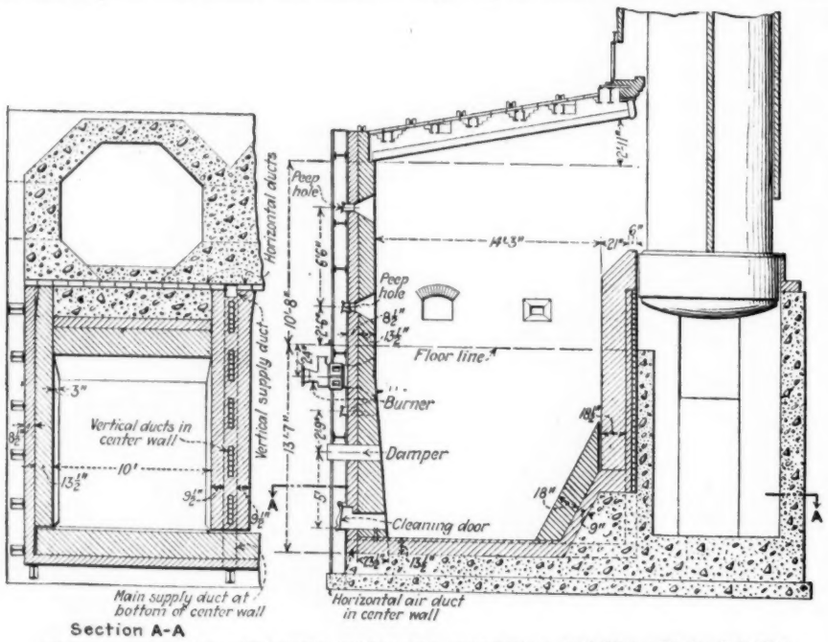



FIG. 6—SECTION THROUGH FURNACE SHOWING VENTILATING DUCTS

Feed water for the boilers comes chiefly from the hotwell, which receives its supply from the tailrace discharging the condenser water to the sewer, although some condensate from process steam used in the factory, from the hot-water heater and the clean drips from the plant, are returned directly to the open feed-water heater.

As the makeup water from the hotwell is partly condensate mixed with a much larger proportion of river water coming from the jet condensers, it contains considerable scale-forming matter and is therefore passed through a hot-process softener and treated with lime and soda ash before being delivered to the open feed-water heater. The equipment has capacity to heat and treat 8,000 gal. of water per hour and in addition, to heat 4,000 gal. of condensate per hour. When necessary, makeup water from the industrial system may be admitted to the heater under float control.

From the open heater the feed water passes through a sand filter and V-notch meter to either one of two single-cylinder double-acting steam pumps, which force the water through the economizer to the boilers under

the control of pump governors and feed-water regulators. The main feed line is supplemented by a wash line having taps into either drum of each boiler.

### Electric Generating and Refrigerating Units

For the power and lighting service, 440-volt three-phase 60-cycle current is generated by two engine-driven units, each rated at 750 kw. The engines are of the unaflow type with 28x36-in. cylinders and a speed of 150 r.p.m. Each unit is served by a 34½-in. jet condenser rated to condense 15,000 lb. of steam per hour, with 1,000 gal. of 75-deg. water per minute at 9-lb. pressure.

In the factory there is demand for considerable refrigerating capacity for molding the chocolate and for an air-conditioning system to keep certain rooms at the proper temperature and humidity the year around. A direct-expansion ammonia system is installed and centralized in the power house, where there are two steam-driven ammonia compressors, a steam condenser common to both machines and other auxiliary equipment. Each machine has a rating of 200 tons of refrigerating capacity, giving a total of 400 tons which may be required under maximum conditions. Ordinarily, however, one machine will supply the service. The ammonia condenser, which is of the atmospheric type, is made up of 22 sections 12 pipes high, of 2-in. pipe 20 ft. long. Cooling water comes from the cold well and, after passing over the stands of condenser piping, is utilized in the steam condenser serving the compressors. From the power house a 2½-in. liquid and an 8-in. suction line pass through the underground tunnels to the various points of service in the manufacturing buildings and to the cooler in the drinking-water system.

To drive the ammonia compressor, unaflow engines are again employed. With cylinders 18x24-in. and a speed of 200 r.p.m., they are rated to deliver 212 i.hp. One steam condenser serves the two engines. As with the power units, the condenser is of the jet type, of 30-in. size, and has a capacity to condense 4,500 lb. of steam per hour with 450 gal. of water per minute at 75 deg. and 9 lb. pressure.

Centrifugal pumps serve the three condensers. Those for condensers Nos. 1 and 2, serving the generating units, have a 6-in. discharge and a double drive consisting of a 20-hp. turbine and an induction motor of equal power at the opposite end of the shaft. Either turbine or motor does the driving, depending on the need for exhaust steam. The condenser for the compressor engines is served by a 5-in. centrifugal pump driven by a 20-hp. induction motor. A 3-in. hotwell pump driven by a 10-hp. motor supplies the feed-water system with the required amount of makeup water.

### Co-ordinating Power and Heating Demands

One of the interesting features of the plant is the heating system and its co-ordination with the power units. The local conditions, such as the large area covered by the various buildings, the desirability of uniform temperatures and the universal effort made throughout the works to secure high economies led to the selection of a hot-water system under forced circulation. The heaters and pumps are located in the power house in near proximity to the condensers and the feed-water heater. Exhaust steam from the engines is utilized in the heater and at the same time a partial and varying vacuum is carried on the engines, depending upon the outside temperature and therefore the temperature of water required in the heating system. For example, the average outdoor temperature in Milwaukee for the entire heating season approximates 33 deg. F. According to the schedule drawn up for the plant, this calls for an outgoing water temperature of 150 deg., which will permit of a vacuum of 22 in. on the engines operating in conjunction with the heating system and delivering their exhaust steam to it. As the outside temperature rises and falls, the schedule calls for varying temperatures of the heating medium and the vacuum in the condensers is readily adjusted to accord with these temperatures. As a consequence the steam consumption of the engines under heating operation is reduced over what it would be with exhaust steam heating at atmospheric pressure, or in other words, from the steam required for heating, a greater byproduct in the form of electric current is made possible.

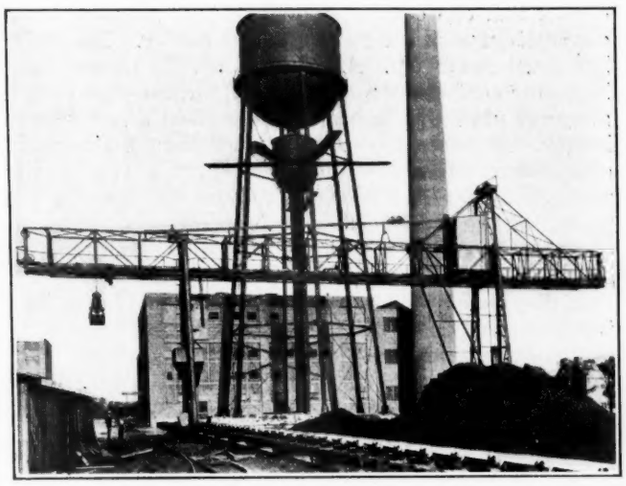


FIG. 8—REAR VIEW OF PLANT, SHOWING COAL STORAGE AND GANTRY CRANE

Generally, with such a co-ordination of services, a surface condenser has been employed, the heater being placed between the engine and the condenser. The present installation is unusual in that jet condensers requiring a constant supply of water at a constant pressure of 9 lb., have been selected to form a part of the combination. As the quantity of condenser water cannot be varied, it is necessary to change the temperature of the water to produce the various degrees of vacuum called for by the operating schedule. This was effected by connecting the suctions of the condenser pumps to two sources of supply—one a cold-water service line and the other the hotwell drawing its supply from the tailrace carrying the overflow condenser water to the sewer. By the adjustment of a valve in the cold line, manipulated from a stand on the engine-room floor, the supply of cold water coming under head to the pumps may be throttled or increased, and the pump allowed to draw more or less of the warmer water from the hot well to make up the constant volume required and to give the temperature corresponding to the desired vacuum.

Fig. 7 shows the piping system by which this co-ordination of services is effected. It will be seen that the exhaust from the two generator engines is discharged into a ring system of 16-in. piping to which are con-

nected, as indicated, the two condensers, the atmospheric relief lines and the riser *A* to the exhaust-steam hot-water heater, the heater itself being on the engine-room floor above. A blank flange at *B* provides for the connection of another heater as soon as its services may be required. Returns from the heater are brought back through pipe *C* from which the condensation is collected in receiver *D* to be returned to the feed-water heater, and the air and vapor pass on into the exhaust line at *E* and eventually to either one of the two condensers.

Line *F* is the suction for condenser pump No. 2. It is connected to the cold line *G* and also to the hotwell at *H*. The valve determining the relative quantities of cold and warm water, and therefore the vacuum to be obtained, is at *I*.

Reference to the drawing will show that the system is so valved that either condenser may serve either engine and one condenser, or the two, may operate in conjunction with the exhaust-steam heater. The system has great flexibility. At night, when the power load is light, the condensers may be cut off entirely and exhaust steam at atmospheric pressure delivered directly to the heater. At such times the exhaust from the ammonia compressor engines is delivered to the ring system through pipe *J* and is thus available for heating purposes, although normally these engines operate full condensing, as the day power load is in excess of the heating requirements.

It may be stated that at present the maximum heating load is 27,000,000 B.t.u. per hour. There is the equivalent of 110,000 sq.ft. of direct radiation, which for the time being has been served by the one exhaust-steam heater containing 1,560 sq.ft. of surface and rated to heat 3,300 gal. of water per minute from 172 to 190 deg. F. with steam at atmospheric pressure. This exhaust heater is supplemented by a vertical live-steam heater containing 349 two-inch tubes six feet long.

Two 8-in. centrifugal pumps, each driven by a 60-hp. motor, circulate the water throughout the heating system. Main trunk lines extend from the power house through the tunnels to the direct radiation (pipe coils and radiators) and to the indirect blast heaters of the ventilating system in the administration building.

Other services centered in the power plant are the domestic hot-water and drinking-water systems. The former has a storage heater 6 ft. in diameter and 16 ft. long. To maintain a constant temperature of water, steam is admitted under the control of a thermostat located in the discharge line of the heater. Pipe lines through the tunnels conduct the warm water to the various points of service. To insure warm water of uniform temperature at the outlets, constant circulation is maintained by a 3-in. centrifugal pump driven by a 7½-hp. induction motor.

The drinking-water system has been isolated from all other piping in the plant. It will be recalled that the initial supply comes from the well on the property. A closed cooler equipped with direct-expansion ammonia coils is located in the power plant and, as with the hot water, constant circulation throughout the system is effected by a motor-driven pump.

The entire plant was designed and installed under the supervision of the engineering department of Elines, Incorporated, although credit is given to Almirall & Co., for the co-ordination of the power and heating services and the installation of all piping.

## DATA ON PRINCIPAL MECHANICAL EQUIPMENT IN POWER PLANT OF ELINE'S INCORPORATED

### BOILERS AND AUXILIARIES

| | |
|---|---|
| Boilers—4, vertical water tube | Wickes Boiler Co. |
| Steam-making surface, sq.ft. | 5,000 |
| Operating pressure, lb.-gage | 175 |
| Superheater, deg. F. | 100 |
| Steam temperature, deg. F. | 478 |
| Superheaters, 4, Foster | Power Specialty Co. |
| Furnace volume, cu.ft. | 3,500 |
| Cu.ft. of furnace volume per sq.ft. of steam-making surface | 0.7 |
| Burners, 8, cast-iron, horizontal, 8 in. diam. | Fuller-Lehigh Co. |
| Arches, 4, flat suspended | M. H. Detrick Co. |
| Fans, 4, down draft, No. 38, air to furnace | B. F. Sturtevant Co. |
| Air pressure, oz. | 5 to 8 |
| Drive, 7½ hp. ind. motors, 1,800 r.p.m. | Allis-Chalmers Mfg. Co. |
| Economizer, 1, cast-iron, serves all boilers | Green Fuel Economizer Co. |
| Surface, sq.ft. | 5,240 |
| Stack, brick | Streator Red Brick |
| Height above boiler room floor, ft. | 250 |
| Diameter at top, ft. | 12 |
| Tile lining, ft. | 125 |
| Ash removal, steam-jet system | Vacuum Ash and Soot Removal Co. |
| Feed-water softening and heating installation | H. S. B. W. Cochrane Corp. |
| Hot-process softener, open heater, V-notch meter. Capacity to heat and treat 8,000 gal. per hour and heat additional 4,000 gal. per hour of condensate. | |
| Feed pumps, two, 16x10x16-in. | American Steam Pump Co. |
| Pump governors and feed-water regulators | (Copes)-Northern Equipment Co. |

### HEATING AND DOMESTIC HOT WATER

| | |
|---|---|
| Heating system and all piping | Almirall & Co. |
| Hot-water exhaust heater, heating system | Griscom-Russell Co. |
| Surface, sq.ft. | 1,560 |
| Capacity to heat 3,300 gal. per min. from 172 to 190 deg. | |
| Live-steam heater, heating system | Griscom-Russell Co. |
| Surface 349, 2-in. tubes, 6 ft. long. | |
| Pumps, 2 centrifugal, 8 in., heating system | Allis-Chalmers Mfg. Co. |
| Drive, 60-hp. induction motor | |
| Heater, domestic, 266 sq.ft. brass tubes | Griscom-Russell Co. |
| Circulating pump, 3-in. cent. | Allis-Chalmers Mfg. Co. |
| Drive, 7½-hp. induction motor | Allis-Chalmers Mfg. Co. |

### COAL HANDLING AND PREPARATION EQUIPMENT

| | |
|---|---|
| Crane, gantry, electric | T. S. Watson Co. |
| Span, 75 ft.; bucket, 1 cu.yd. | |
| Conveyor, belt, 18 in. | Weller Manufacturing Co. |
| Magnetic Separating unit | Dings Magnetic Separator Co. |
| Crusher, single roll, 25 tons per hour | Jeffrey Manufacturing Co. |
| Drive, 5-hp. induction motor | Allis-Chalmers Mfg. Co. |
| Bucket elevator 30 tons per hour | Webster Manufacturing Co. |
| Cradle feeder, 12x12-in. | Fuller-Lehigh Co. |
| Drier, indirect fired, 54-in.x42 ft. | Fuller-Lehigh Co. |
| Capacity, 10 tons per hour, moisture from 10 to 2 per cent. | |
| Drive, 7½-hp., ind. motor and Foote reducer | Allis-Chalmers Mfg. Co. |
| Exhauster fan, hot gases from drier | B. F. Sturtevant Co. |
| Drive, 7½-hp. induction motor | Allis-Chalmers Mfg. Co. |
| Bucket elevator, 30 tons per hour | Webster Mfg. Co. |
| Drive, 7½-hp. induction motor | Allis-Chalmers Mfg. Co. |
| Screw conveyor, 12 in. | Webster Manufacturing Co. |
| Drive, 5-hp. induction motor | Allis-Chalmers Mfg. Co. |
| Mills, two, air separator and pulverizer | Fuller-Lehigh Co. |
| Size, in. | 46 |
| Capacity, tons per hour | 4.6 |
| Drive, 100-hp. ind. motor | Allis-Chalmers Mfg. Co. |
| Silent-chain drive | Link Belt Co. |
| Screw conveyor over bunkers, 9 in. | Fuller-Lehigh Co. |
| Drive 5-hp. ind. motor | Allis-Chalmers Mfg. Co. |
| Screw conveyor, serving drier, 3 in. | Webster Mfg. Co. |
| Drive, 1-hp. ind. motor | Allis-Chalmers Mfg. Co. |
| Pulverized coal feeders, 5 in., eight | Fuller-Lehigh Co. |
| Speed reducer | Reeves Pulley Co. |

### ELECTRIC GENERATING EQUIPMENT

| | |
|---|---|
| Generators, two 750-kw. 440-volt three-phase 60-cycle 150 r.p.m. | Allis-Chalmers Mfg. Co. |
| Drive, unaflow engines, 28x36 in. | Nordberg Mfg. Co. |
| Condensers, jet, 34½-in., 15,000 lb. steam per hour | Schutte & Koerting |
| Pumps, two centrifugal, 6 in. | Allis-Chalmers Mfg. Co. |
| Drive, 20-hp. turbine and induction motor | Allis-Chalmers Mfg. Co. |
| Gravity oiling systems and filters | Richardson Phenix Division, S. F. Bowser Co. |
| Switchboard | Westinghouse Electric & Mfg. Co. |

### REFRIGERATING EQUIPMENT

| | |
|---|---|
| Compressors, ammonia, two, 200-ton | Vilter Mfg. Co. |
| Drive, unaflow engines, 18x24 in., 200 r.p.m. | Nordberg Mfg. Co. |
| Condenser, jet, 30-in. 4,500 lb. steam per hour | Schutte & Koerting |
| Pump, centrifugal, 5 in. 20-hp. motor | Allis-Chalmers Mfg. Co. |
| Condenser, ammonia, atmospheric, 22 sections, 12 pipes high, 2-in. pipe 20 ft. long | Vilter Mfg. Co. |

### WATER SUPPLY

| | |
|---|---|
| Pumps, two, centrifugal, 6,000 gal. per min. | Allis-Chalmers Mfg. Co. |
| Drive, 150-hp. induction motors, squirrel-cage | Allis-Chalmers Mfg. Co. |
| Gravity tank, 300,000 gal., 160 ft. head | Pittsburgh-Des Moines Steel Co. |
| Pump, one centrifugal, 3,000 gal. per min. | Allis-Chalmers Mfg. Co. |
| Drive, 200-hp. induction motor | Allis-Chalmers Mfg. Co. |
| Pump, one centrifugal, hotwell, 3 in. | Allis-Chalmers Mfg. Co. |
| Drive, 10-hp. induction motor | Allis-Chalmers Mfg. Co. |
| Pump, centrifugal, drinking water, 3 in., 5-hp. motor | Allis-Chalmers Mfg. Co. |

### METERS

Republic Indicating and Recording Steam-Flow Meters on each boiler.
Bristol recording thermometers.
Uehling $CO_2$, indicating and recording, for each boiler.
Bristol Recording Pressure Gages.

# Selection of Lubricating Oil for Internal-Combustion Engines

By W. F. OSBORNE
Supervisor Manufacturers' Service, Texas Company

THE successful lubrication of an internal-combustion cylinder depends upon the engineer's ability to effect a compromise between the conflicting requirements of the engine and the physical and chemical properties of the lubricating oil. There are a thousand and one brands of oils on the market, many of them exactly alike, most of them high-grade oils as far as their refinement is concerned, and most of them will give first-class service if used in the right place in the correct amount.

A great many oils will give good service for a while, but sooner or later trouble arises through carbon deposits, excessive dilution or accumulation of sediment. Other oils may not form any carbon deposits at all, but the consumption will be high. If the engineer cannot get an oil that will have a low consumption and a minimum carbon deposit at the same time, it is better to use a little more oil if by doing so the carbon deposit can be eliminated. The cost of removing the carbon will be far greater than the cost of the extra oil.

## Oil Characteristics

Generally speaking, filtered oils will give better service under the severe conditions met in the internal-combustion cylinder than the non-filtered oils. Carbon deposits, if formed, are likely to be less in quantity and less adhesive in nature, and the oil is less susceptible to decomposition. In other words, its life will be longer. Of course there are some engines where the consumption, through improper mechanical design, is so great that almost any fairly good grade of machine oil will work just as well as a high-grade filtered cylinder oil. An engineer who is unfortunate enough to have such an engine does not need advice on oil.

Internal combustion cylinder oils are made in a wide range of viscosities. There is not, at the present time, so far as the writer knows, any really scientific basis that the engineer can use in determining what viscosity will give the best results in any given engine. Long experience, gained by many trials of various oils in all kinds of engines, combined with good judgment and a knowledge of the working conditions, seems to be about the only way we now have of selecting lubricating oils for this service.

If we find that a certain kind of oil having definite properties works all right in a given engine, we can form a pretty good idea as to its value in some other engine with slightly different conditions. That is about as far as we can go, and until we get a more complete quantitative knowledge of all of the effects discussed in the preceding articles, as well as many others besides, we will have to continue with our present methods.

Considering viscosity only, the general practice is to use light or medium viscosities for engines using the splash method of lubrication, and medium or heavy oils for force feed. Tight pistons require thinner oils than loose pistons, and high temperatures heavier oils than low temperatures. Dilution by fuel affects viscosity particularly severely, and the original viscosity should be high enough to counteract the effects of unavoidable dilution of the lubricant. If the viscosity becomes too low through such dilution, all the oil should be removed from the crankcase and replaced with fresh oil. Reclaimers for removing the fuel and sediment are effective and aid in lowering the cost for oils.

Volatility (not flash point) is a very important physical property, as it indicates the ability of the oil to stay on the cylinder wall under the working temperatures. It also influences the quantity of oil required to maintain the film at the proper thickness. In other words it is an indication of the consumption of the oil when used in the cylinder. It is unfortunate that we have no better standard than the flash test for measuring relative volatility at the present time. This test does not indicate the true relative volatility of two oils at any temperature other than their flash temperatures, and certainly not at the temperatures and pressures to which such oils are subjected within the cylinder.

Surface tension with respect to various metals, or adhesion if we wish to call it that, has not been measured satisfactorily, although it is undoubtedly of great importance in the maintenance of the oil film. Likewise the susceptibility of the oil to decomposition cannot yet be measured with any degree of satisfaction. The carbon test is held by many to be a good indication of the quality of an oil in this respect, although there are some oils of high-carbon residue that give less trouble than others of low-carbon residue under identical conditions. We can expect, in general, that an oil with a low-carbon residue is quite likely to perform satisfactorily.

## Worth of Pour Test

Another physical property that must be given due consideration where engines are likely to be exposed to low temperatures is the pour test. This is particularly important in the selection of oils for drip cups and splash-oiling systems because the quantity of oil furnished varies directly with its fluidity. If the oil is too thick at low temperatures, it will not flow fast enough to the parts needing it, and these parts become hot or wear through lack of oil. The naphthene oils have a natural zero pour test and are particularly desirable for use under such conditions.

Complete specifications covering the various grades of internal-combustion cylinder oils as adopted by the Committee on the Standardization of Petroleum Product and issued in bulletin form by the Bureau of Mines, are given below.

| | Extra-Light | Light | Medium | Heavy | Extra-Heavy |
|---|---|---|---|---|---|
| Flash point, Deg. F. | 315 | 325 | 335 | 345 | 355 |
| Fire point, Deg. F. | 355 | 365 | 380 | 390 | 400 |
| Viscosity Saybolt at 100 Deg. F. | 140–160 | 175–210 | 275–310 | 370–410 | 470–520 |
| Pour test not above, Deg. F. | 35 | 35 | 40 | 45 | 50 |
| Carbon residue not above per cent | 0.10 | 0.20 | 0.30 | 0.40 | 0.60 |

Acidity: Not more than 0.05 milligrams of potassium hydroxide shall be required to neutralize one gram of the oil.
Corrosion: A clean copper plate shall not be discolored when submerged in the oil for 24 hours at room temperature.
Emulsifying Properties: The oil shall separate (this means that there shall be only a slight cuff between the water and the oil) in 30 minutes from an emulsion with: (1) Distilled water; (2) 1 per cent salt solution; (3) normal caustic solution.

# Boiler-Tube Failures

By HAYLETT O'NEIL

IN A modern boiler plant, well designed and well operated, boiler-tube failures are infrequent. This is partly due to the increasing use of surface condensers, boiler feed-water softeners, makeup evaporators, regular and frequent boiler-cleaning periods, and other factors helping to keep the boiler clean and insure proper internal circulation. However, it is by no means certain that the exact causes of failures are fully understood if one may judge from the literature on the subject and the great variety of specific remedies offered.

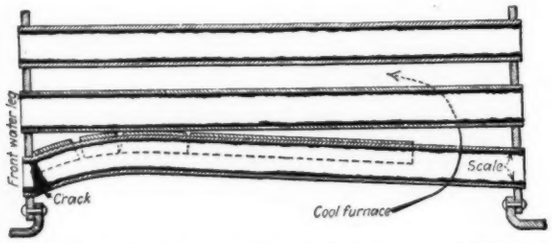



FIG. 1—NATURE OF FAILURE WITH T-TILE BAFFLE

Boiler tubes may fail when a certain spot, becoming hotter than the rest, expands or bulges, thus setting up local strains which rupture the tube. These spots need not be heated red hot; the required condition is sufficient unevenness of temperature to cause rates of expansion in adjacent parts of a tube varied enough to strain the metal. If the strain occurs at the seam of a lap-welded tube, it is likely a split will occur. Hence it is important to roll a tube in place with the seam at the top in order to avoid a split which might occur in the event of a blister.

**IN AN eight-boiler plant employing single-pass horizontal baffling, tube failures to the number of 140 occurred in 60 days. A careful study revealed the cause, and the remedy applied reduced the loss to less than five tubes per year.**

In a certain plant which for several years had its full share of troubles, the bulges in the tubes were not local and failures occurred not as splits or blisters, but in the form of tubes cracking square off at the front ends in nearly all cases.

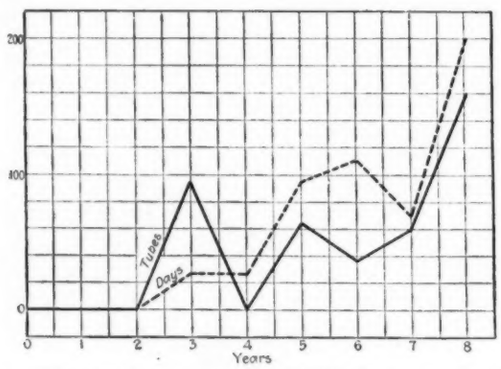



FIG. 2—RELATION OF TUBES PURCHASED TO DAYS ON SPRING WATER

The plant contained eight 2,500-sq.ft. horizontal water-tube boilers with single-pass horizontal baffling. At the outset the baffling was made up of T-tile located on top of the lower row of tubes. Coal was fired in double-retort underfeed stokers of the old, front, hand-cleaned type. The boilers operated at a fairly steady rate, averaging 135 per cent of normal load with swings up to 200 per cent. This required that the fires be cleaned four times each day.

From the outset of the investigation it was noticed that every failure but one occurred in the bottom row of tubes. Remarkable it is that the failures did not occur over the fire, during regular operation, but while the boilers were cooling down almost immediately after being withdrawn from commission for cleaning. Then, with loud reports one or more of the bottom tubes would crack off at the ends next to the front water leg. The nature of the break is shown in Fig. 1.

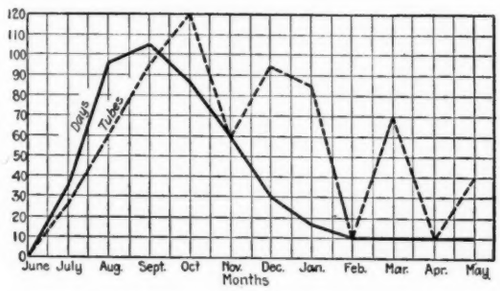



FIG. 3—TUBE FAILURES AND DAYS ON SPRING WATER BY MONTHS DURING EIGHT-YEAR PERIOD

It was noticed that few tubes next to the side walls failed. The only difference in conditions was that these tubes were partly covered with slag or fused brickwork, so it was felt that the protective coating of the slag was in some way responsible for the saving of these tubes. In view of the dangerous conditions it was decided to change the lower baffle to C-tile, as the conditions surrounding the center tubes would then approximate those of the side tubes and because this method, if correct, would most quickly bring relief.

The results were mainly disappointing. Due to blanking off the tubes from the radiation of the walls and the fuel bed, the furnace temperature rose to such a point that the furnace lining simply streamed down onto the grates, while clinkers in the fuel bed became intolerable. In fact careful checking for several days showed that the time required to clean a furnace fire was nearly doubled. Moreover, the daily plant coal

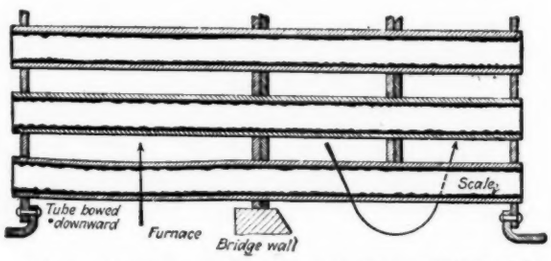



FIG. 4—SCALED TUBE BOWING DOWNWARD IN VERTICALLY BAFFLED BOILER

consumption went up with no more apparent cause, and it was evident that the final solution of the difficulty lay elsewhere.

However, the experiment apparently demonstrated that a reason for the failures was the repeated cooling of the furnace during the cleaning periods and if the

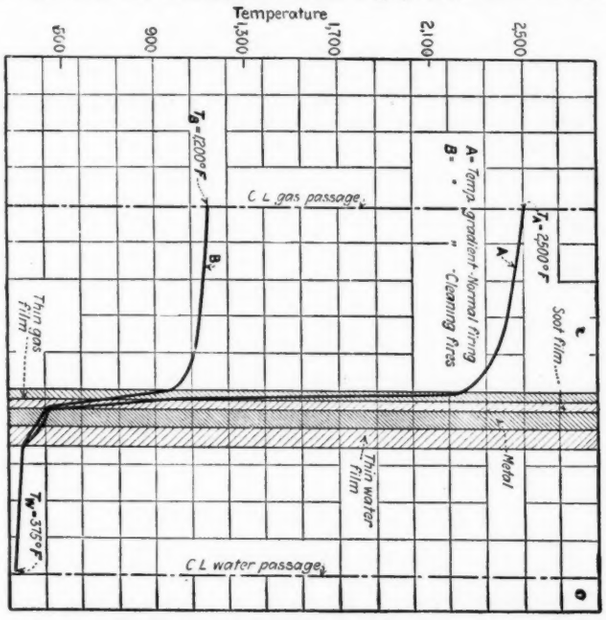



FIG. 5—TEMPERATURE GRADIENT WITH CLEAN TUBE

tubes could be protected from the resulting temperature extremes, failures could be reduced. A platinum couple thermometer indicated that the furnace temperature varied from about 2,500 deg. F. during normal operation to about 1,200 deg. F. during the cleaning period.

Tubes that were taken out were generally bowed upward with offsets from a straight line varying from 3 to 5 in. Material cut from any part of these except at the ends, and submitted to hammer tests appeared to be of normal strength and quite sound. On the other hand, at the broken ends the tubes were so hard and brittle that only a slight blow of a tack hammer was required to break off small pieces.

From the boiler repairmen it was learned that for several years the number of failures had been somewhat reasonable during part of the year. Usually in the spring and summer the plant would run on without any trouble, when suddenly several tubes, one after another, would fail in the late fall and winter.

It was felt that the ultimate answer lay in scale which during certain parts of the year deposited at the rate of ¼ in. in 60 days, while during other periods formed only a slight film.

Up to this time the period between turbining of boilers varied from 60 to 90 days. Since most of the steam was exhausted to a jet condenser or used in process work, most of the feed water was raw makeup. As no attempt was made to soften it, the rate of scale formation must have been in proportion to the water fed and to the percentage of scale-forming salts it contained. Except for the small increase due to heating during the winter, the steam demand, and consequently the makeup water requirements, were fairly constant throughout the year, but it developed that there were two sources of feed water.

During the winter and spring, or the wet season, feed water was taken from the municipal system, of which the source was a mountain stream. As the supply was largely surface water, it was fairly soft and free from scale-forming matter. During the dry season feed water was drawn from a spring in which the water was charged heavily with bicarbonate of lime. Naturally, prolonged use of this water would result in considerable scale formation. The periods of excessive failures, as reported by the boiler repairmen, apparently were linked up with the periods during which the spring water was used exclusively.

A careful record, by months for several years, of the days the spring water was used, was available, and a search was made for a similar record of tube replacements. Unfortunately, there were no such data, but there was a complete record of purchases with the number of tubes and the exact dates. It was felt that inasmuch as purchases usually would occur according to needs, the dates of such would approximate those of failures.

In Fig. 2 is shown, plotted according to years, the days during which feed water was drawn solely from the spring and the number of tubes purchased. The coincidence of the two factors was so remarkable that there was little doubt that the spring water was responsible for the trouble. To further confirm this, recognizing that the use of spring water was seasonal according to the dry periods of the years, a plat was made by months of the total days feed water was drawn only from the spring and the number of tubes purchased (see Fig. 3). This plat further confirmed the theory that failures and tube purchases followed periods of extensive use of the spring water as boiler feed, and also the reports of the repairmen.

During the interim between cleaning periods the scale was found to have accumulated in a uniform coating

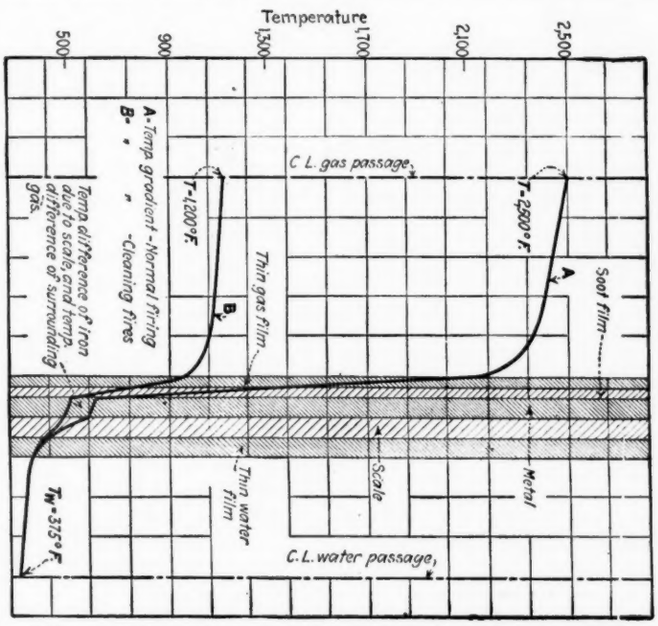



FIG. 6—TEMPERATURE GRADIENT WITH DIRTY TUBES

about ¼ in. thick. This uniformity would naturally give uniform heat insulation, so that all parts of the tube subjected to the same external temperature would have the same temperature and rate of expansion. This is the reason blisters did not occur.

In the ordinary vertically baffled boiler the writer has

noticed that under similar scale conditions the tube generally bows downward as in Fig. 4. This indicates that the under side of the tube has been heated hotter than the upper, which is reasonable with this arrangement of baffling, and hence has bulged toward the fire, just as a stove lid or frying pan bulges away from the cooler side toward the hotter. However, in the case under immediate discussion the tubes bowed upward

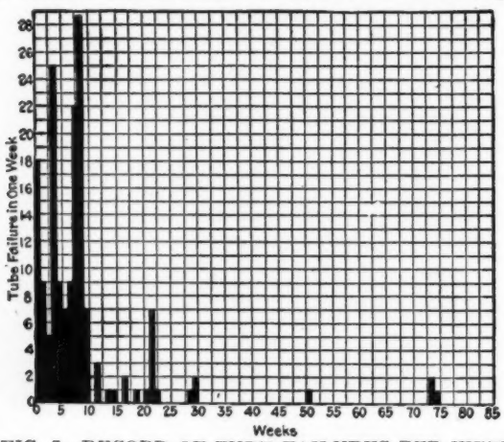



FIG. 7—RECORD OF TUBE FAILURES PER WEEK

away from the fire, showing that during part of the time, at least, the tops of the tubes were hotter than the bottoms. This condition helped point out the trouble.

For a long time it had been a theory of British engineers and physicists, such as Perry and Reynolds, that in a clean boiler the metal temperature would be practically equal to that of the adjacent water, regardless of the temperature of the surrounding gas. About 1914 this was proved practically by the United States Bureau of Mines. On the other hand, scale insulates the iron from the water, so that with scale, the hotter the gas is, the hotter will be the metal (see Figs. 5 and 6). The question is, How did the top of the tube get hotter than the bottom?

The answer proved to be that the T-tile kept the top of the tube hot during both normal operation and part of the cleaning periods. The temperature of this tile according to the pyrometer was close to 2,500 deg. F. The lower part of the tube was surrounded by furnace gas which fluctuated between 2,500 deg. during firing conditions and about 1,200 deg. during cleaning periods. Inasmuch as during a cleaning period the front doors had to be open, temperature variations could not be eliminated.

On account of the heat conductivity of the iron it would naturally be impossible to maintain for any considerable time a temperature difference between the top and bottom of the tube, but calculations have been made by the writer indicating that only a few hundred degrees difference is required to curve an 18-ft. tube as much as 3 in. out of line. Such a temperature difference seems to be entirely feasible.

What actually happened is this: At first a tube would be humped upward slightly during a cleaning period and restraightened afterward as soon as the bottom could be expanded under the influence of the furnace temperature. Every time cleaning or banking took place, the expansion and contraction cycle was repeated. Therefore the tube was subjected to repeated bending upward and downward several times a day. The strains were concentrated at the tube sheet, where finally the tube became brittle and lost its tensile strength. Finally, the tube would be strained beyond its elastic limit and take on a permanent set. When the boiler was cooled for cleaning, the temperature was reduced nearly to room temperature, causing extreme tension in the tube due to contraction, and the tube would break.

The final solution of the trouble came in the regular adding to the boiler water of an internal treatment, the base of which was caustic soda. A given quantity of this was pumped into each boiler at regular intervals, and twice each week boiler waters were titrated for soda concentration. By keeping the soda concentration under 40 grains per gallon, excellent results were obtained. After a run of from 60 to 90 days on spring water, only a thin film of scale was formed, and there was no foaming. The T-tile were finally replaced entirely. Fig. 7 shows the record of tube replacement by weeks during the period of the severe trouble and for nearly two years afterward. This chart shows that the manner of handling the trouble was correct. Certainly, no steam-power plant is even approximately safe unless the boilers are kept clean religiously.

# German Oil-Engine Developments*

Before the world war the feeling among Germans as well as among engineers of other countries was that the Diesel represented the most efficient cycle for heat engines. All who were at all interested in internal-combustion engineering were well agreed on the proposition that the use of highly compressed air as the fuel injection and atomizing medium was necessary if high efficiency and satisfactory service were to be obtained from an engine using liquid fuel. In addition, the modification of the original Diesel theory of combustion at constant temperature to give combustion of constant pressure was conceded to be the final word in efficient fuel combustion. The result of this atmosphere of satisfaction with and confidence in the efficiency of the Diesel air-injection constant-pressure cycle was to direct all the efforts of internal-combustion engineers toward improvements in details of structure. Certain builders adopted the horizontal frame for the engine and improved upon the early design of the cylinder head; others constructed vertical engines, some with A frames and others with box frames. Spray valves of numerous shapes and possibilities were brought out, all of these retaining the early idea of using perforated disks or washers and high-pressure air to break up the fuel body. Fuel pumps were likewise experimented with and improved upon, but in almost all instances the pump was designed to deliver a measured charge of oil to the fuel-valve casing. The actual injection of this oil was left to the action of air pressure as advocated by Dr. Diesel.

In all the important before-the-war constructions the Diesel constant-pressure air-injection principle was strictly adhered to. True, there were other and minor engine types invented and manufactured. A few builders adopted the Brons plan of primary cup ignition (called Hvid in the United States), while hot-ball or surface ignition engines of fairly large powers were constructed, but these departures from the Diesel cycle were acknowledged even by the makers to be accom-

*An interview with Dipl-Ing. Franz Schultz, Director and Chief Engineer, Motorenfabrik Deutz, of Germany.

panied by higher fuel consumption and less satisfactory service, although they were justified for small powers on the basis of lower first cost. In addition, the attitude of the builders was one of secrecy, and it was impossible for a fellow manufacturer to visit the inner sections of the engine factory of any builders. Information as to results of important experiments was held within the factory walls. Frequently, a dozen builders were investigating the same problem unbeknown to one another.

During the war thousands of technical men and factory mechanics were drawn into the army. Here they came into contact with not only the product of their home factory but that of their competitors. As a result the thick veil of secrecy was lifted and engine builders began to exchange ideas in a way that was unheard of prior to the war.

After the war the men came back with a feeling of unrest and dissatisfaction with old ideas and machinery. There existed a tendency to abandon old habits of thought and to bring out new types of machinery.

This was especially true with respect to the internal-combustion engine and especially with regard to the old attitude of satisfaction with the Diesel cycle. There had been a few attempts to develop a different engine prior to 1914, but now almost every engine builder turned his laboratory over to the work of perfecting a different type—one that would not require the expensive troublesome air compressors, and which, while being as efficient, would be cheaper to build.

### Deutz Builds Solid-Injection Engine

The Motorenfabrik Deutz, or as it is usually termed in America The Deutz Co., had patented a solid-injection engine in 1913; however, this was but one of several types being built by this manufacturer, the list including Brons motors, Diesel air-injection, surface-ignition and low-compression gasoline and kerosene engines. Since the war this concern, together with the majority of engine builders, has definitely embarked on the manufacture of solid-injection oil engines. The compression pressures range from 250 to 400 lb., and the engines operate on what may be called the "dual cycle." The injection of the fuel is early in order to allow time for its vaporization; some method of giving turbulence in the oil vapor and air charge is always provided, and combustion is in the main at constant volume followed by a slight amount of burning at constant pressure. The maximum explosive pressure is in most designs held below 650 lb. per square inch, higher pressures requiring excessive metal.

It is the general feeling among German engineers that the Diesel air-injection system will in the future be confined to units of over 1,000 hp., while on engines below this capacity the solid-injection cycle will be employed. This would indicate that the low pressure of the hot-wall or so-called surface-ignition engine will be increased to around 300 lb. and this type converted into a solid-injection engine.

Before the war internal-combustion engines were not built on a production basis in any European country. The enormous number of engine cylinder sizes and types prevented more than a limited number of engines of one size being built at a time. Costs were correspondingly high. Now most factories have by a process of elimination reduced the number of cylinders of different sizes that need to be manufactured. By choice of cylinder capacities an engine of practically any power may be supplied by grouping the required number of cylinders. Production methods may be and are being followed; in the Deutz factory cylinders in groups of 100 to 200 are passed through the shops. The workmen are paid on a piece-rate basis. Few inspectors are employed, although all the parts are made to gage. Accuracy of workmanship is obtained by making each mechanic responsible for the parts he machines, poor work being discovered and discarded when the engine is assembled on the test floor. Test-floor men are paid by the hour in order to eliminate any tendency on their part to pass faulty parts.

The output of the many oil-engine factories is far greater than the output before the war. The demand in Germany for oil engines has been increased by reason of the high price of coal, much of the coal being imported from England. Steam plants are as a consequence expensive to operate and are giving way to the oil engine. If petroleum oil were required in the German oil engines, the cost of the imported liquid fuel would make the oil engine an uneconomical unit, but fortunately the engines have been developed to a point where coal-tar oil can be burned with complete satisfaction. In this way the coal supply is consumed in the most economical manner, most of it being subjected to distillation to give tar oil, coke, ammonia, etc.

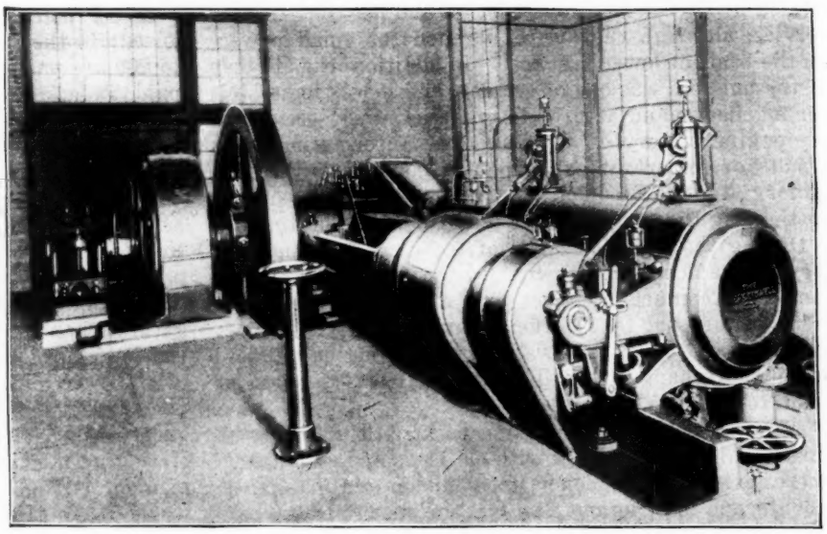
### German Export Policy

In the export of oil engines the manufacturers of the United States will find much of interest in the methods followed by German engine builders. The more important of these manufacturers maintain a complete sales organization covering the entire world. For example, one prominent builder has over four hundred salesmen in South America, Egypt, India, China, etc. These representatives are not mere brokers or agents handling engines as a side line. On the contrary, they are direct representatives, selling the builders' product and educated to feel that the builders' interests are their interests and that for them to profit the builders must profit. If the engine sales are insufficient to give the salesman a profitable business, the engine builder takes on some other line of machinery that can be readily sold in the territory under question. In this way the sales agent is able to increase his profits, but at the same time he is tied closer than ever to the engine builder, since the latter supplies the extra lines of machinery.

The German export engines are finished according to the demand of the country into which the engines go. Local desires as to painting, extra parts, crating, etc., are complied with and for this reason German engines command a premium of as much as 20 per cent over competing engines in many countries. In making export prices, the factory cost has but slight influence, since, owing to the rate of exchange, the cost of a German engine when translated into dollars is less than a fifth of the cost of an American engine of like power. The quoted price depends on the price prevailing in the country to which the engine is going—this being based on quotations of English and American engine builders. The extent of the German foreign trade in oil engines may be judged by the fact that in one South American country a German builder maintains a repair shop having a payroll of forty men. In every city of over 10,000 persons this concern has its representative. With the prices higher than American quotations, it is evident that their export trade is due to the energy displayed by the manufacturers.

# Unaflow Valve Gear of American Design*

**Description of the Several Valve Gears Used on the Filer & Stowell Unaflow Engines. Method of Setting the Valves**



THE first unaflow engine cylinders built by Filer & Stowell Co. replaced Corliss-valved cylinders on engines direct connected to ammonia compressors. For this reason it was necessary to make use of a valve-gear design that would enable the alteration in the old engines to be reduced to a minimum. Consequently, the cylinder, while having a central exhaust, was not provided with the customary poppet valves. Instead, a piston-type drop valve was used, the actuating mechanism being a modification of the Corliss disengaging latch arrangement.

In the later designs the double-ported piston valve was retained on engines of medium speed, but the eccentrics were placed on a layshaft along the cylinder, the valve gear being modified to conform to the new design of drive. A cross-section of the cylinder appears in Fig. 2. The steam valves are of the piston type, working in removable bushings set into the cylinder head cavities and take steam at the top and bottom of the valve. By this construction the entire cylinder head is steam-jacketed. As with all unaflows, exhaust takes place at the center of the barrel through a series of ports leading to an exhaust belt and pipe.

The steam eccentric is keyed to the layshaft and drives the eccentric rod *C*, Fig. 3, which is fastened to the steam arm *P*. The latch *E*, which is of the gravity type, engages with the latch block *F* and lifts the valve by rotating the valve arm *G* about the fulcrum pin.

The governor is driven from the layshaft by bevel gears and runs at engine speed. The governor arm *H* is fastened to the knockoff lever *I*, and the latter, by striking the latch finger *K*, disengages the valve arm from the steam arm and the valve closes. Being a piston valve, there is no blow when the valve closes. The spring in the bonnet provides the force necessary to close the valve while the air trapped below the gag-pot piston brings the valve to rest.

The setting of the eccentrics and valves is similar to the setting of a long-range Corliss gear. A tram mark is placed on the valve stem, and the distance from this point to the top of the valve-stem guide, or the distance *X* in Fig. 3 (the amount being stamped on the valve stem), gives the lap for which the valve is set at the factory. The eccentrics are usually set with no lead and are keyed to the layshaft. The eccentric rods must be adjusted in length to cause the latch to engage the latch block when the eccentric is in line with the eccentric rod, this position being the extreme position of the eccentric. The bevel gear connecting the layshaft to the crankshaft is so arranged that the lead of the two valves may be altered by shifting the layshaft ahead or back respectively to the crank position. The proper lead to give the engine can be determined only by indicating the engine after the valves are adjusted. When engines are to operate non-condensing, the cylinder is provided with mechanically operated auxiliary exhaust valves. A lever is fitted to the exhaust-valve gear to enable the point of auxiliary exhaust-valve closure to be regulated by the engineer to conform to the existing back pressure.

Such a gear as in Fig. 3 may not be operated at high speeds, consequently for speeds above 150 r.p.m. the Filer & Stowell unaflow is fitted with double-beat poppet valves, as shown in Fig. 4. The valve seats in

*This is one of a number of articles on unaflow engine valve gears. Those that have appeared are: "Another Corliss Engine Firm Building Unaflow Engines," Oct. 17; "Setting Ames Unaflow Engine Valves," Oct. 24; "Auxiliary Exhaust Valves on Unaflow Engines," Nov. 7; "A Unaflow Engine with Single Beat Poppet Valve," Nov. 14; "Setting Valves on the Nordberg Unaflow Engine," Nov. 21; "A Unaflow Engine with an Unusual Valve Gear," Nov. 28.

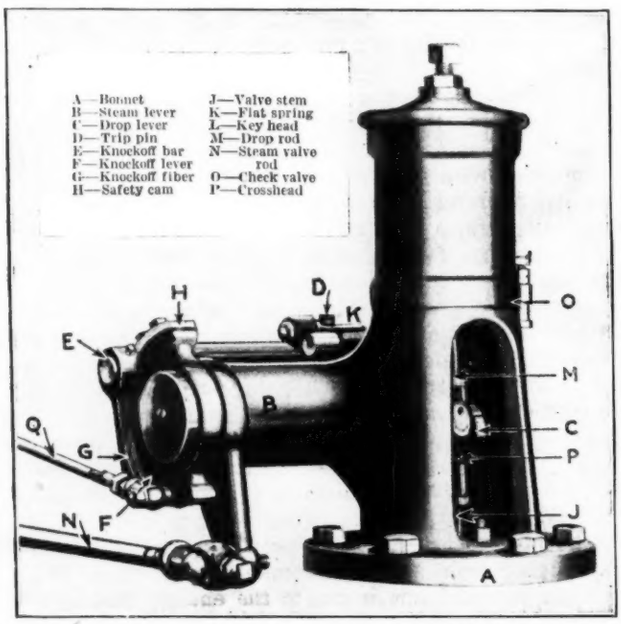



FIG. 1—VALVE GEAR FOR REBUILT CORLISS ENGINES

a removable cage resting in the cylinder head. The upper end of the valve stem, Fig. 5, screws into the crosshead *O* which carries two rollers, an opening roller *R* and a closing roller *P*. The upper, or opening, roller *R* rests on an idler roller *Z* supported on the lever *W*.

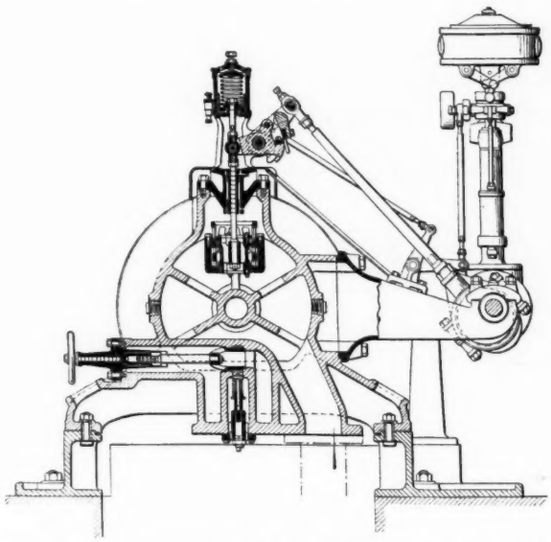


FIG. 2—DETACHING GEAR FOR UNAFLOW ENGINE

The roller *Z* contacts with the upper cam face of the cam rod *S*. The cam rod *S* is connected to the eccentric, which in turn is driven by the steam eccentric mounted on the layshaft. The travels of the steam eccentrics

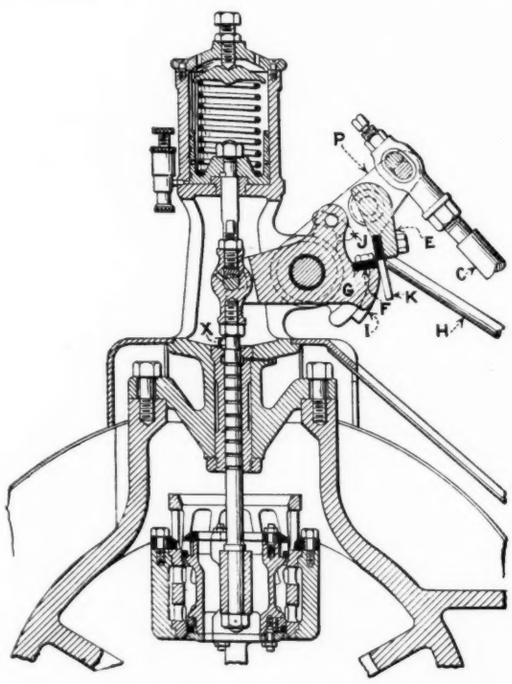



FIG. 3—DETAILS OF PISTON DROP VALVE

are controlled by the centrifugal governor mounted on the layshaft.

As the eccentric rod moves downward, the upper cam face contacts with the roller *Z* and at the same time the closing roller *S* comes under the high part of the lower cam face. The further downward motion of the cam rod lifts the idler *Z* and the roller *R*; this motion opens the valve. The reversal of the eccentric-rod travel causes the closing roller *P* to contact with the lower cam face, closing the valve.

The first step to be taken in setting these valves, is to see that with the valve closed the roller *Z* just touches the roller *R* and the cam face, while the closing roller *P* clears the lower cam face by 0.002 in. This clearance may be measured by a feeler gage, and the valve stem should be adjusted in length to give this clearance.

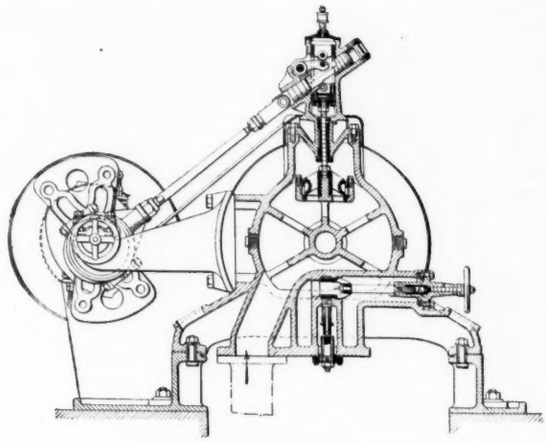


FIG. 4—HIGH-SPEED POPPET-VALVE GEAR

The eccentric rods are connected to the eccentric and to the cam rod by right- and left-hand threads, so that adjustment for proper lead in case one of the valves is "off" is made easily. Since the governor does not permit of a constant lead from no load to full load, the valves should be set to have practically no lead at

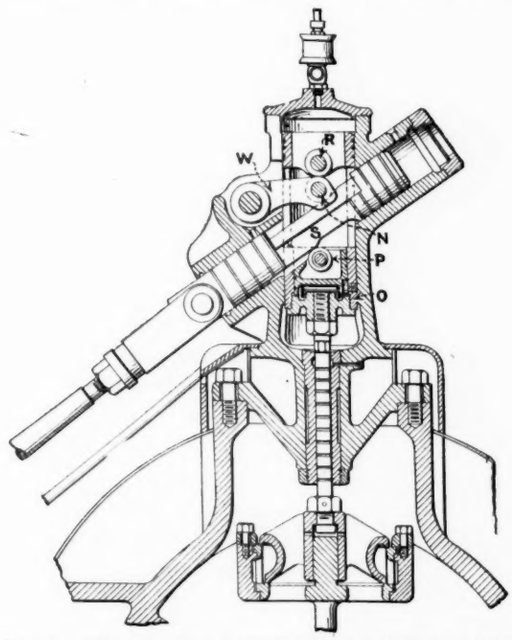



FIG. 5—DETAILS OF DOUBLE-BEAT POPPET VALVE

no load, which setting will give the correct lead for full load.

The valves should be checked for lead at full load by placing the governor in its full-load position and turning the engine over until the valve starts to open. If the lead of both valves is excessive or insufficient, the layshaft is retarded or advanced as required.

# Starting Direct-Current Motors—Time-Limit Type Controller

## What the Time-Limit Principle Is and How This Type of Controller Operates—Operation of a Type of Controller Working on the Counter-Electromotive-Force Principle

BY CHARLES A. ARMSTRONG

ONE of the first methods of starting an electric motor is indicated in Fig. 1, where a resistance is connected in series with the armature and cut out by moving one end of an arm across a number of contacts as the motor comes up to speed. With slight

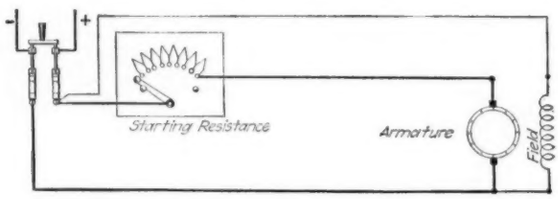


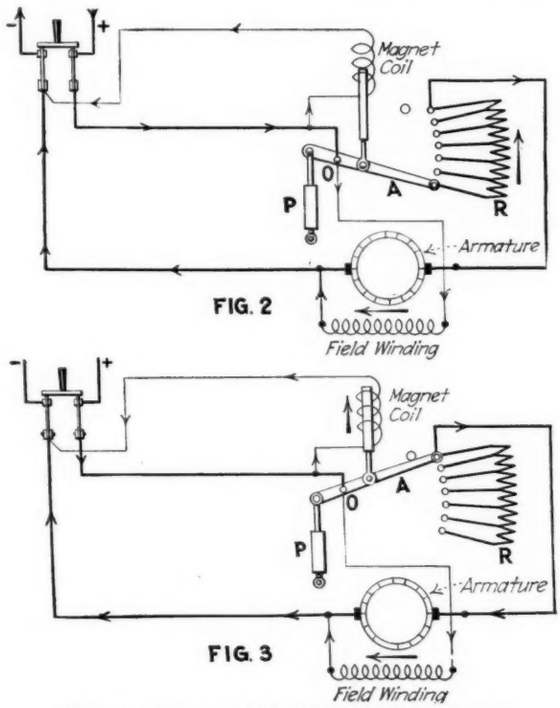

FIG. 1—DIAGRAM OF SHUNT MOTOR AND MANUAL-TYPE STARTER

modifications this scheme of starter is in wide use today. This was also one of the earliest ideas incorporated into an automatic starter for a motor. A schematic diagram of such an automatic starter is shown in Figs. 2 and 3. In this case the arm is moved across the resistance contacts by a coil pulling up an iron core attached to the arm. When the switch is closed, current flows from the + side of the line through the starting resistance *R* and the armature to the — side of the line. There is another circuit from the resistance arm through the field winding and to the — side of the line. A third circuit is through the magnet coil, as indicated by the arrowheads. This allows the motor to start with all the resistance in circuit. The magnet coil, being energized, pulls up its core and with it arm *A*, and cuts the resistance out of circuit until the last point is reached, as in Fig. 3. In this figure the armature circuit is from the + side of the line through arm *A* and the armature to the — side of the line. All the starting resistance is out of circuit and the motor is up to full speed.

To prevent the coil from cutting the resistance out too quickly, a dashpot *P* is attached to one end of the arm, which is fulcrumed at *O*, so that when the right-hand end of the arm moves upward over the resistance contacts, the left-hand end pushes the plunger down into the dashpot. This dashpot can be adjusted so as to allow the resistance to be cut out in a given time, irrespective of the load on the motor, and for this reason it is called the time-limit type. If the dashpot is adjusted so that the coil can pull up its core in five seconds, the resistance will be cut out of circuit in this time whether the motor is starting light or under an overload. This is one of the objections to this class of starter — it cannot automatically adjust itself to load conditions on the motor. The magnet coil is directly across the line and will develop the same pull on the resistance arm irrespective of the load on the motor, consequently with a given adjustment of the dashpot the starting resistance will be cut out in a given time. If the motor were started light, it might be all right to cut the resistance out in two or three seconds, whereas, if it were starting under a heavy load, ten or fifteen seconds might be required to accelerate the load. In adjusting the controller, about the best that can be done is to adjust the time to meet the full-load conditions of the motor; nevertheless, if the frequent starting and stopping is done at light loads, much time is lost in getting the machine under way.

### TIME-LIMIT TYPE RESTRICTED TO SMALL SIZES

The type of controller indicated in Figs. 2 and 3 is limited to small sizes on account of the current that may be handled on the resistance contacts without serious burning. Where large-sized controllers of this type are used, arm *A*, instead of cutting out resistance




FIGS. 2 AND 3—DIAGRAMS OF TIME-LIMIT AUTOMATIC STARTER

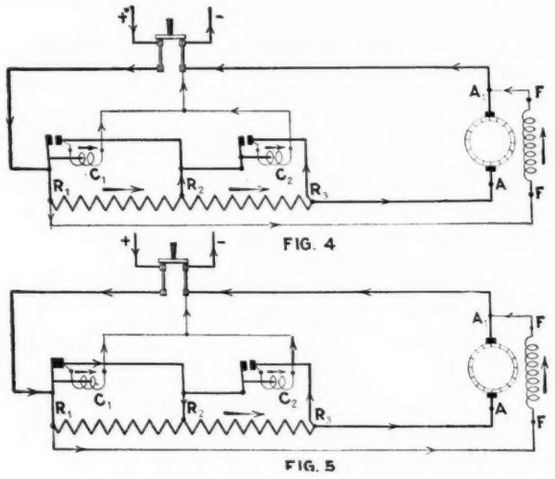
as it moves over the contacts, closes coil circuits and this in turn pulls in contactor switches that short-circuit a section of the starting resistance. This type of equipment is used under a wide variety of conditions even at the present time, where it gives satisfactory service.

In many applications a controller that will accelerate the motor according to the load is preferable. That is, under light load the starting resistance is cut out quickly, and under heavy loads more time is allowed. A type of controller that does this is the one that operates on the counter-electromotive force principle described in "Starting Direct-Current Motors" in the Oct. 3 issue. In this type the time required to cut out the resistance depends upon how fast the voltage builds up across the armature terminals, and this time varies with the load on the motor, being shorter with light loads than with heavy ones.

### Operation of Controller Working on the Counter-Electromotive Force Principle

A scheme for operating a controller on what is a modification of the counter-electromotive force principle is shown in Figs. 4, 5 and 6. In this type the contactor coils can all be wound for the same voltage, therefore it is not necessary to open all but the last coil after the resistance has been cut out, as is the case in the straight counter-electromotive force type, to prevent burning out the contactor coils wound for the low voltage. In Fig. 4, instead of the coils being connected across the armature as in the counter-electromotive force type, they are connected to points in the starting resistance, and one side of the line.

When the line switch is closed, the armature circuit is from the + line through the starting resistance $R_1$ $R_3$ through the armature to the — side of the line. There is a direct circuit for the field from the + to the — side of the line. This starts the motor with all the resistance in circuit with the armature. Contactor coil $C_1$ is connected from $R_2$ to the — side of the line, and coil $C_2$ is connected from $R_3$ to the — side of the line. Assume that the contactor coils are designed to close on 165 volts and that at the instant of starting 215 of the 240 line volts is used up in the




FIGS. 4 AND 5—DIAGRAM OF COUNTER-ELECTRO-MOTIVE-FORCE AUTOMATIC STARTER

starting resistance, which would leave 25 volts at the armature terminal. If in the starting resistance one-half the volts drop, or 215 ÷ 2 = 107.5, is between $R_1$ and $R_2$, there will only be cross coil $C_1$, 240 — 107.5 = 132.5 volts and it cannot close its contactor. Since all the starting resistance is in series with coil $C_2$, at the instant of starting, it will have the same voltage across its terminals as the armature, or 240 — 215 = 25. As this coil is designed to close on 165 volts, it will not close.

Assume that the motor is connected to a normal load and that it begins to revolve when the line switch is closed. As it increases in speed, the counter-electromotive force increases and the starting current decreases. A building up of the counter-voltage and a reduction in the current causes the voltage to increase across the armature terminals and decrease across the starting resistance. Consider that the starting current is reduced by the motor increasing in speed until only 75 volts is required to cause the current to flow from $R_1$ to $R_2$; this will leave 240 — 75 = 165 volts to cause

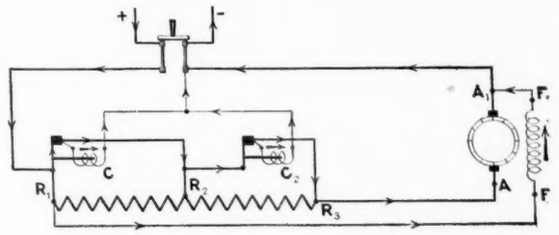



FIG. 6—SAME AS FIG. 4, BUT WITH BOTH CONTACTORS CLOSED

current to flow from $R_2$ through $C_1$ to the — side of the line and the contactor will close as in Fig. 5. Closing contactor $C_1$ short-circuits the resistance between $R_1$ and $R_2$ and connects coil $C_1$ directly across the line. Cutting out the resistance section allows the starting current to increase and increase the speed of the motor. As the motor speeds up, the current decreases and the volts drop in the resistance section decreases. When the current drops to a value to where there is only 75 volts drop across the resistance section $R_2$, $R_3$, coil $C_2$ will close its contactor, as in Fig. 6, since 240 — 75 = 165 volts will be impressed on its terminals. When $C_2$ closes, all the resistance is cut out of circuit and the motor comes up to full speed. Under this condition the armature circuit is through contactors $C_1$, $C_2$ and the armature to the — side of the line. Each coil is connected from its respective contactor and the — side of the line, so that full voltage is applied to their terminals. In practice the controller may have three or more contactors connected into different points of starting resistance, but their operation will be the same as explained in the figures. The principles explained in Figs. 2 and 4 are applied in a great many ways in different classes of motor controllers, but no difficulty should be encountered in following the circuit when the fundamentals outlined in the foregoing are understood.

The next article will explain the fundamental principle that is involved in a number of current-limit type controllers.

---

If careful examination be made when reading the scale at the top of the liquid, it will be found that the electrolyte in a battery cell piles up around the stem of the hydrometer higher than the general level. This amounts to about one small scale division, so in reading, the last division that can be clearly seen above the liquid should be noted and one more added; that is, if the reading be 1.185 to the last division mark in sight above the electrolyte, read it 1.186 sp.gr. The hydrometer can sometimes be more easily seen if placed on the far side of the cell.

# Value of Specifications in Purchasing Refrigerating Equipment*

By A. C. BISHOP

**DO YOU want to buy the kind of plant you need and know that it is being purchased at the lowest possible price? If so, prepare complete specifications and compel every bidder to figure on this common basis. This is the only method fair to both buyer and seller.**

YEARS ago, operating engineers who were acquainted with refrigerating and ice-making machinery were scarce; in fact, an ice company usually had to educate power-plant engineers to run its plant. Since then the number of plants has increased many times and refrigerating machinery has been developed to a high degree. Unfortunately, there are those who still purchase equipment in the same way as was done years ago instead of availing themselves of the service of competent engineers.

There is no doubt that any of the legitimate refrigerating-machine builders can supply a complete and efficient plant, but there is a question whether, in the face of intensive competition where price figures so much, the proposal submitted does include everything it should. To place confidence in some one concern and pay its price may be all right, but who knows whether another concern would not have built just as good a plant for a great deal less money. How is it then possible to buy this plant—the kind of plant you should buy—and know that you bought it for the best price? The answer is, draw up complete specifications upon which all bidders must figure.

## Method of Purchase

The first question that arises is: Should this plant be bought in its entirety, delivered and erected, or should it be purchased piecemeal, f.o.b. the factory? Many contend that when you purchase the material f.o.b. from various manufacturers, the responsibility is divided accordingly. The different parts of the apparatus are so closely related that much trouble and delay is experienced when things are at fault; weeks are some times spent trying to place the blame. The total plant cost is never known until everything is completely installed and running. Often the owner must contend with one make of compressor, another make of condenser, a different make of brine cooler, brine agitators, etc., and for what reason? If these several parts were complete in themselves and did not function with other apparatus, there might be some excuse for this state of affairs. Refrigerating and ice-making apparatus must be erected or put together upon its arrival on the purchaser's premises. It is not worth much until it is put in operation. Then why not let the people who made it also erect it and run it for a while to prove its worth?

The chief thing to accomplish in drawing up specifications is to *think* of every piece of machinery and apparatus needed, the number, size, etc., then put this information down in detail, in black and white, in specification form calling for the whole list of material to be delivered, erected and put into running order.

Every proposed plant should first be put on paper. Drawings should be made showing the relative location of all machinery, and specifications prepared describing the machinery. This should be done thoroughly so as to enable the contractors located in various parts of the country to figure the job intelligently without visiting the premises, thus saving the expense of many trips usually made by the various machine manufacturers' representatives and which must ultimately be paid by the purchaser.

## Specifying Compressor Wanted

The importance of a specification calling for certain types of apparatus is attested by the many different kinds and styles usually offered. Take for example, the ammonia compressor. Several builders are advocating vertical semi-inclosed medium-speed machines, several others sell horizontal semi-inclosed medium-speed machines, and still others advocate semi-inclosed high-speed machines. The slow-speed horizontal duplex compressor, either direct connected or belted, is another type still in favor. Each one of the several types of machines no doubt has its particular merits, but the one best suited to meet the plant requirements should be decided upon, and bids entertained upon this one to the exclusion of the others. If the purchaser is undecided as to the type of machine to select, then separate bids should be invited on the several types.

It is most important to give consideration to the volumetric efficiency of the compressor offered. A comparison of bores and strokes of compressors means nothing. One compressor will have a poppet valve flush with the head, another a plate valve with its accompanying cage clearance; still another will have the suction valve in the piston and the discharge valves set at right angles to the bore, meaning additional clearance in the discharge-valve ports. So, in making a comparison of the capacity of the compressors offered, it is most important to pay attention to their volumetric efficiency.

## Accessories

Many things should be mentioned in the specifications covering the compressor, such as the oiling system to be furnished, the packing, full-sized bypass for starting, relief valves to satisfy the safety code, extra suction and discharge valves, railings, foundation bolts and templet, foundation-bolt sleeves and the smoothness of the shop coat of paint and filler.

Ammonia condensers may be either atmospheric or double-pipe, top inlet and bottom outlet, flooded or bleeder type. They can be twenty pipes high, twelve pipes or almost anything else. For a given capacity one manufacturer might offer much more surface than another. So again, the specification should give the type of condenser desired, the number of stands, the

*Paper read before the annual meeting of the National Association of Practical Refrigerating Engineers, St. Louis, Mo., Nov. 2, 1922.

pipes high, the kind of pipe, the kind of fittings, whether flanged or screwed, the center to center of pipes, and the style of headers. Without a specification the items mentioned are bound to be at variance in the several proposals submitted and a comparison of prices would be impossible. As the condenser surface influences the power consumption, care should be exercised in asking for the right amount.

Ammonia receivers are made in many different sizes. A specification should give a certain size for all to figure on. They should be equipped with gage glasses and 1¼-in. purge connections.

Oil separators, too, are furnished in different sizes. The specification should call for one of ample size with drain line. It should be so located to have not less than twelve feet of horizontal run into it. The size of this twelve feet of pipe should be increased over that from the compressor in order to reduce the velocity of the gas and increase the efficiency of the oil separator.

Every plant should have an ammonia distiller. The specification should specify the size, also equipment, such as safety valve, pressure gage and drain.

### Pipe Connections

The specification covering ammonia connections is important. Manufacturers make both flanged and screwed valves and fittings. One or the other should be called for so that all may figure alike. The valves should have flanged bonnets, not screwed. Wrought or steel pipe should be furnished, say, extra heavy on high-pressure lines and standard full weight on low-pressure lines. Gaskets should be either lead or pure gum as agreed upon. Joints should be made up with either solder or litharge.

Direct-expansion piping should be specified either flanged or screwed. Wrought iron or steel pipe only should be acceptable. The valves and fittings to be used should be described, and details should show the size and kind of paper hangers wanted.

There are so many details to a freezing system that only a specification can place bidders on a common ground. A given tonnage of ice can be made each day with a variable number of ice cans and a variable amount of evaporator surface, but the power consumption per ton of ice produced will be influenced largely by the surfaces in this part of the apparatus. The number of cans to be used should first be decided upon, as the dimensions of the ice tank are dependent upon the number of cans.

### Ice-Tank Specifications

The specifications should, therefore, give exact dimensions of ice tank, thickness of material to be used in tank, bulkheads, partitions, etc. Seams scarfing, reinforcing and painting, together with the necessary outfitting boxes and drains, should be outlined. As the brine circulation is dependent upon the arrangement of bulkheads and partitions, a drawing showing what is wanted should accompany the specification.

If the ice tank is provided with evaporator coils, the specification should call for a certain number of coils and state whether the coils are to be made up endless or with fittings. The total number of feet of pipe to be furnished, the size, material whether iron or steel, extra heavy, or standard full weight, all are items of importance. Where coils are of some length, flanges must be introduced and a drawing should be furnished showing how these flanges are to be protected from damage from the ice cans. The arrangement of headers and how they are to be built should be mentioned. The drain on the bottom headers is important and should not be forgotten. If the ice tank is provided with a brine cooler, the specification should give the diameter and length of the shell and the number and size of tubes. The horizontal joint in the shell can be constructed in different ways, but if a fire weld is desired, it should be specified and insisted upon. The plates should be of certain specified thicknesses and kind.

### Tank Parts

In purchasing ice cans, very little attention is usually paid to the quality of galvanizing or the total weight of can. It behooves one to investigate, for there is a real differenece in cans. The specification should mention the size of can, gage of metal, size of band. location of hole in band and the kind of seams.

Propellers may be either horizontal or vertical. There is a chance for variance of material supplied in this particular if a specification does not govern. The size, pitch and speed of propellers should be called for, as well as horsepower and speed of motors. Brine circulation plays an important part in the efficiency of an ice tank and brine-circulating apparatus, and the arrangement of bulkheads and partitions to harness the brine should not be passed upon too lightly.

The hoist and traveler can be of different capacities and design. The number of cans to be handled at a time should first be decided upon and a hoist and traveler specified accordingly. If any six cans are pulled at a time, then the crane must necessarily be provided with three motors, one to operate the traveler, one to move the trolley and one for the hoist. If, say, three 300-lb. blocks are handled at a time, the crane need be furnished with only one motor, that for the hoist.

Ice dumps for one, two or three cans should be built of wood and put together with bolts and angle iron. They last longer than steel dumps. Dumps for six cans must be steel, but should be lined with wood. The wood dumps for one, two or three cans should be lined with wood wearing strips. If the plant is of any size at all, the thawing should be done in a dip tank. Better time can be made and the life of the can is longer.

In coil ice-making tanks many believe that a salt other than calcium chloride can be used. The specifications would state definitely which salt should be furnished, sodium or calcium chloride.

### Ammonia Charge

Where a complete plant is furnished, the ammonia charge should be included and the specification should state that the upper gage glass in the receiver should be, say, one-half full when the plant is operating at full capacity and the compressor is being back frosted or being operated with suction gas from and at saturation.

If the low-pressure air system is employed, the specifications should describe the air blowers furnished as well as air piping and other apparatus necessary in this system of ice making. If the high-pressure air system is to be used, the specifications should describe the air compressor to be furnished, as well as the air driers and other necessary apparatus.

Air blowers can be either direct connected, belted or belted with idler pulley. The specification should name several makes of blowers that would be acceptable and state the speed at which they are to operate. The

motor horsepower and speed too, should be given. Opinions differ on the speed and horsepower of the blowers, hence the value of the specification. The same is true of air compressors used in the high-pressure system.

There is a big difference in water pumps. Bronze-fitted pumps are better than others not fitted so. Horizontally split centrifugal pumps are better than pumps having removable end plates. In larger capacities pumps are built to operate at several speeds for the same capacity, and usually a slower-speed pump will last longer. Centrifugal pumps are without a doubt the most economical to operate and install, where they will meet the requirements. Engineers can design centrifugal pumps to pump a given quantity of water at a certain speed against a definite head, and if this head should vary, the efficiency of the pump will vary. It is very important that enough time be spent to determine the exact static head at which the pump will operate, together with the friction head which you are likely to have in pipe and fittings and apparatus such as double pipe condensers. Specifications should call for certain makes of pumps to be furnished.

There are many things such as the kind of motor compensators and starters, kind and size of valves and fittings and painting the apparatus, that should be described and called for in the specifications. There are so many ways of accomplishing approximately the same thing and so many different styles, sizes and qualities of apparatus and materials that can be furnished, that unless bidders are figuring on the same list of materials, it is worthless to compare bids.

## Grand Tower High-Pressure Steam Station

Another station* to generate steam at 400 lb. pressure and superheat it to 725 deg. F. is to be erected by the Middle West Power Co., a subsidiary of the Middle West Utilities Co., at Grand Tower, Ill., which is about 100 miles south of St. Louis on the Mississippi River. The plant is to serve the mining region in that part of the state. Its output has been contracted to the Central Illinois Public Service Co. and will be delivered over a transmission line owned by that company, extending 40 miles to West Frankfort. The station may have an ultimate capacity of 100,000 kw. in four units. Construction work on the building to contain two units is now under way, but for the time being only one unit will be installed. It will have a rated capacity of 25,000 kw. at 100 per cent power factor, and will generate three-phase 60-cycle current at 13,200 volts. For transmission the tension will be 66,000 volts.

The turbine will be of the new Westinghouse single-cylinder design built for a steam pressure of 350 lb. gage at the throttle and a temperature of 700 deg. F. The speed of the unit is to be 1,800 r.p.m.

As the rise and fall of the river at Grand Tower approximates 40 ft., vertical condensers are to be installed in a well, as at Kansas City and Cincinnati. There will be two machines, and consequently two condensers, per well, with a corresponding intake well in which the circulating pumps are to be installed. These pumps are to be of the vertical type with the motors on the floor above, out of reach of the water. The condensers are of the Worthington two-pass vertical type with the circulating-water inlet at the top and the outlet also at the top. Each condenser will contain 35,000 sq.ft. of surface. All the condenser auxiliaries are to be motor-driven.

Steam is to be bled from the lower stages of the turbine at about 8 lb. pressure to heat the feed water. The extracted steam will pass into either one of two closed heaters located between the hotwell of the condenser and the usual open feed-water heater. Condensation from the closed heaters will be returned to the hotwell of the condenser and makeup will be introduced at this point. The condensate pumps will draw from the hotwell of the condenser and force the feed water through the closed heaters to the open feed-water heater, from which the supply of boiler water passes down to the turbine-driven feed pumps.

The boilers, of Babcock & Wilcox design, are to be practically identical, except that they are not so wide, with those to be installed in the Waukegan station of the Public Service Company of Northern Illinois. In the first installation there will be three, each containing 11,600 sq.ft. of steam-making surface, 2,700 sq.ft. of superheating surface and about 7,000 sq.ft. of economizer.

Reference to the description of the Waukegan boilers appearing in the Sept. 12, 1922, issue of *Power*, will show that these new high-pressure boilers are of the inclined header design. Those at Grand Tower are to be 28 sections wide, the sections being double-decked and connected to 54-in. cross-drums. The lower sections are made up of eight 3¼-in. tubes, 15 ft. long. Each upper section is composed of seventeen 2-in. tubes of the same length. The tubes of the lower sections are exposed for their full length to the direct radiant heat of the furnace, this portion of the boiler being without baffles.

On account of the high superheat required and to keep down the amount of surface, the superheater is to be located between the 3¼-in. tubes and the 2-in. tubes. It will be composed of four rows of 2-in. superheater loops.

Gases from the furnace will pass over the lower tube sections, thence over the superheater and into the upper deck of tubes, which have a single vertical baffle, making this portion of the boiler two-pass. The gases are taken from the boiler between the upper and lower sections of tubes, passing into the economizer placed at the rear of the boiler setting. The economizer is of the transverse-tube "Duratex" design, built by the Babcock & Wilcox Co. for a working pressure of 450 lb. It will be 21 sections in height, each section containing twenty 2-in. by 16-ft. tubes connected by wrought-steel headers. The economizer arrangement calls for the upward passage of the water and downward passage of gas. The counterflow principle, coupled with proper gas and water velocities, leads to high heat transfer rates and corresponding economizer efficiency.

From the boiler floor to the bottom of the front tube header the headroom is to be 21 ft. 7 in., giving a furnace of large proportions. Each boiler will be equipped with Illinois forced-draft chain-grate stokers with nine zones. The stokers will be 17 ft. wide and 18 ft. long, giving a grate area of 306 sq.ft. and a ratio of grate area to boiler-heating surface of approximately 1 to 36. Wrought-steel water boxes connected into the circulation of the boiler will protect the side walls and the bridge wall.

Sargent & Lundy, Inc., are the engineers responsible for the design and installation of the station.

*See *Power*, Oct. 17, p. 630.

# Sampling and Analyzing Coal

## Correct Method of Sampling—Figuring the Ultimate Analysis from the Proximate—Estimating the Hydrogen from the Volatile Combustible Matter—Estimating the Total Carbon from the Fixed Carbon and Volatile Combustible Matter—Problem Illustrating Method

BY JOSEPH R. DARNELL
Combustion Engineer, Sinclair Refining Company

TOO much stress cannot be laid upon the careful and methodical sampling of coal. Even more important than the accurate analysis is the care that must always be exercised to obtain a sample that is truly representative. The pith of the problem is very aptly expressed in a remark once made by a prominent combustion engineer. He said, "Any amateur can make the analysis, but it takes a good man to get the sample." Isn't it true? Time and again false conclusions have been drawn, and coal that was really of good quality has been condemned on account of poor sampling. In like manner coal of an inferior grade has been allowed to pass on account of careless sampling.

### METHOD RECOMMENDED BY THE BUREAU OF MINES

The method of sampling recommended by the United States Bureau of Mines gives the most satisfactory results. In sampling coal where quantities of carload size or larger are handled, not less than one thousand pounds should be obtained for a sample. This amount should be carefully taken from all parts of the car or bin. The gross sample should then be reduced by quartering and discarding alternate shovelfuls, care being taken that all lumps are broken up as the reduction proceeds. Finally, by the process of repeated quartering and crushing, a sample weighing about five pounds should be obtained. The largest piece should be about the size of a pea. From this sample two one-quart airtight fruit cans or other airtight vessels may be filled and sent in for analysis.

In order to prevent any undue loss of moisture and to minimize the loss of finely divided particles by gusts of wind, all sampling operations should be conducted where the air is cool and free from drafts.

If it is desired to obtain a general idea of the heating properties of the coal, a *proximate* analysis is made. This includes moisture, volatile matter, fixed carbon and ash. Sulphur is sometimes included, but it is determined separately. For power-plant operation, especially, this type of analysis will show whether or not a coal is adaptable to quick firing and will meet sudden changes in load better than some other grade. If, however, it is desired to calculate efficiency and losses and to tabulate a heat balance, an *ultimate* analysis is required.

### FIGURING THE ULTIMATE ANALYSIS

The ultimate analysis reduces the combustible constituents of the coal to their chemical elements, such as carbon, hydrogen, nitrogen, oxygen and sulphur. Ash is reported the same as in the proximate analysis. The hydrogen and oxygen in the ultimate analysis include the hydrogen and oxygen composing the moisture as reported in the proximate analysis.

However, there are times when it is desired to compute heat losses, although no ultimate analysis is available. Even if the apparatus is at hand to run this analysis, the cost is several times that of a proximate analysis, and it requires greater skill and more careful manipulation. For this reason the writer has studied a large number of coal samples where both proximate and ultimate analyses have been made on the same sample, to determine if there is any constant relationship between the two analyses. More than two hundred samples of Midwestern coals have been under observation. Results have shown that in a majority of cases there is a definite relationship between the two types of analysis, especially in regard to the percentage of carbon and hydrogen.

### ESTIMATING THE HYDROGEN FROM THE VOLATILE COMBUSTIBLE

In Technical Paper 197, the United States Bureau of Mines shows the relation between the volatile matter and ultimate hydrogen. The curve shown therein was re-plotted on a much larger scale, and from this curve Table I was obtained. In preparing this table, the amount of volatile combustible matter (V.C.M.) expressed as a percentage on the moisture-and-ash-free basis, was plotted against the ultimate hydrogen (moisture- and ash-free).

TABLE I—APPROXIMATE RELATION BETWEEN (*A*) VOLATILE COMBUSTIBLE MATTER, AND (*B*) HYDROGEN, BOTH FIGURED AS PERCENTAGES ON THE MOISTURE-AND-ASH-FREE BASIS

This table applies to coals of 12,000 to 15,000 B.t.u. per pound on the moisture-and-ash-free basis.

| A | B | A | B | A | B | A | B |
|---|---|---|---|---|---|---|---|
| 25.0 | 4.30 | 34.0 | 4.87 | 43.0 | 5.30 | 52.0 | 5.60 |
| 25.5 | 4.33 | 34.5 | 4.90 | 43.5 | 5.32 | 52.5 | 5.61 |
| 26.0 | 4.36 | 35.0 | 4.93 | 44.0 | 5.34 | 53.0 | 5.62 |
| 26.5 | 4.40 | 35.5 | 4.96 | 44.5 | 5.36 | 53.5 | 5.63 |
| 27.0 | 4.43 | 36.0 | 4.98 | 45.0 | 5.38 | 54.0 | 5.64 |
| 27.5 | 4.47 | 36.5 | 5.00 | 45.5 | 5.40 | 54.5 | 5.65 |
| 28.0 | 4.50 | 37.0 | 5.03 | 46.0 | 5.41 | 55.0 | 5.66 |
| 28.5 | 4.53 | 37.5 | 5.05 | 46.5 | 5.42 | 55.5 | 5.67 |
| 29.0 | 4.56 | 38.0 | 5.07 | 47.0 | 5.44 | 56.0 | 5.67 |
| 29.5 | 4.60 | 38.5 | 5.10 | 47.5 | 5.46 | 56.5 | 5.68 |
| 30.0 | 4.63 | 39.0 | 5.13 | 48.0 | 5.48 | 57.0 | 5.68 |
| 30.5 | 4.65 | 39.5 | 5.15 | 48.5 | 5.50 | 57.5 | 5.69 |
| 31.0 | 4.68 | 40.0 | 5.17 | 49.0 | 5.51 | 58.0 | 5.69 |
| 31.5 | 4.72 | 40.5 | 5.20 | 49.5 | 5.52 | 58.5 | 5.69 |
| 32.0 | 4.75 | 41.0 | 5.22 | 50.0 | 5.54 | 59.0 | 5.70 |
| 32.5 | 4.78 | 41.5 | 5.24 | 50.5 | 5.56 | 59.5 | 5.70 |
| 33.0 | 4.81 | 42.0 | 5.26 | 51.0 | 5.57 | 60.0 | 5.71 |
| 33.5 | 4.84 | 42.5 | 5.28 | 51.5 | 5.58 | .... | .... |

Table II is the result of a study of Midwestern coals, particularly Illinois, Indiana and Kentucky coals. It was found that there is a relationship between the ultimate carbon and the sum of the volatile matter and fixed carbon. While not absolutely true for every analysis studied, over ninety per cent of the samples under observation came within one or two per cent of the results tabulated. As indicated by the table, the results are applicable only to coals having heating values (moisture free) averaging from 9,500 to 13,000 B.t.u. For some reason the table is particularly unadaptable for coals having heat values (moisture free) above 13,000 B.t.u. In obtaining this table, the *sum* of the percentages of V.C.M. and F.C. (fixed carbon), in mois-

ture-free coal, was plotted against ultimate carbon (moisture free). The former value ranges from 65 to 96 per cent with carbon values given for each 0.1 per cent.

Having the proximate analysis and sulphur value of a coal, one can easily estimate the probable heat value. A more accurate heat value can be determined from the ultimate analysis by Dulong's formula:

$$\text{B.t.u. per lb.} = 14{,}600\,C + 62{,}000\left(H - \frac{O}{8}\right) + 4{,}000\,S$$

where $C$, $H$, $O$ and $S$ represent percentages of carbon, hydrogen, oxygen and sulphur respectively.

If the percentage of sulphur is found along with the proximate analysis, the only other value needed, after the carbon and hydrogen are found from the tables, is oxygen. Oxygen and nitrogen together may be found by subtracting the sum of all other values from 100 per cent. Approximately 1.3 per cent (moisture free) represents a fair average value for nitrogen in Midwestern coals. The percentage of oxygen can then of course, be obtained by difference.

A problem will clear up the use of the tables. Suppose it is desired to find the ultimate analysis and heat value of a Midwestern coal having the following proximate analysis: Moisture, 11.35; volatile combustible matter, 34.62; fixed carbon, 40.63; ash, 13.40. Total, 100 per cent. Sulphur (separately determined), 4.76 per cent.

TABLE II—APPROXIMATE RELATION BETWEEN THE PERCENTAGE OF ULTIMATE CARBON AND THE SUM OF THE PERCENTAGES OF VOLATILE COMBUSTIBLE MATTER (V.C.M.) AND FIXED CARBON (F.C.), ALL FIGURED ON THE MOISTURE-FREE BASIS.

This table applies to coals of 9,500 to 13,000 B.t.u. (moisture free)

Per cent of Ultimate Carbon—Moisture Free

| V.C.M. + F.C. | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 50.26 | 50.33 | 50.40 | 50.47 | 50.55 | 50.63 | 50.69 | 50.76 | 50.83 | 50.91 |
| 66 | 50.98 | 51.06 | 51.13 | 51.20 | 51.27 | 51.34 | 51.41 | 51.48 | 51.56 | 51.64 |
| 67 | 51.72 | 51.79 | 51.86 | 51.93 | 52.00 | 52.07 | 52.14 | 52.21 | 52.29 | 52.36 |
| 68 | 52.43 | 52.51 | 52.58 | 52.65 | 52.72 | 52.80 | 52.87 | 52.94 | 53.01 | 53.08 |
| 69 | 53.15 | 53.22 | 53.30 | 53.37 | 53.45 | 53.52 | 53.59 | 53.66 | 53.73 | 53.80 |
| 70 | 53.87 | 53.95 | 54.02 | 54.10 | 54.17 | 54.25 | 54.32 | 54.39 | 54.46 | 54.53 |
| 71 | 54.60 | 54.67 | 54.75 | 54.82 | 54.90 | 54.97 | 55.05 | 55.12 | 55.19 | 55.26 |
| 72 | 55.33 | 55.41 | 55.48 | 55.56 | 55.63 | 55.70 | 55.77 | 55.85 | 55.92 | 55.97 |
| 73 | 56.05 | 56.13 | 56.21 | 56.28 | 56.35 | 56.42 | 56.50 | 56.57 | 56.65 | 56.73 |
| 74 | 56.80 | 56.88 | 56.95 | 57.03 | 57.11 | 57.18 | 57.26 | 57.34 | 57.42 | 57.50 |
| 75 | 57.58 | 57.67 | 57.75 | 57.83 | 57.92 | 58.00 | 58.09 | 58.17 | 58.26 | 58.35 |
| 76 | 58.43 | 58.51 | 58.60 | 58.69 | 58.77 | 58.86 | 58.95 | 59.04 | 59.13 | 59.22 |
| 77 | 59.31 | 59.40 | 59.49 | 59.57 | 59.65 | 59.74 | 59.82 | 59.91 | 59.99 | 60.08 |
| 78 | 60.17 | 60.25 | 60.34 | 60.43 | 60.51 | 60.60 | 60.69 | 60.77 | 60.86 | 60.95 |
| 79 | 61.04 | 61.13 | 61.21 | 61.30 | 61.39 | 61.47 | 61.55 | 61.64 | 61.73 | 61.82 |
| 80 | 61.91 | 61.99 | 62.08 | 62.17 | 62.25 | 62.34 | 62.43 | 62.51 | 62.60 | 62.69 |
| 81 | 62.78 | 62.87 | 62.96 | 63.05 | 63.14 | 63.23 | 63.32 | 63.41 | 63.49 | 63.57 |
| 82 | 63.65 | 63.74 | 63.82 | 63.91 | 64.00 | 64.08 | 64.17 | 64.26 | 64.34 | 64.42 |
| 83 | 64.50 | 64.58 | 64.67 | 64.75 | 64.84 | 64.92 | 65.01 | 65.10 | 65.19 | 65.28 |
| 84 | 65.37 | 65.46 | 65.55 | 65.64 | 65.72 | 65.81 | 65.89 | 65.97 | 66.06 | 66.15 |
| 85 | 66.23 | 66.31 | 66.40 | 66.49 | 66.58 | 66.67 | 66.76 | 66.84 | 66.93 | 67.02 |
| 86 | 67.10 | 67.19 | 67.28 | 67.36 | 67.45 | 67.53 | 67.62 | 67.71 | 67.79 | 67.87 |
| 87 | 67.96 | 68.04 | 68.13 | 68.21 | 68.30 | 68.38 | 68.46 | 68.55 | 68.63 | 68.72 |
| 88 | 68.80 | 68.87 | 68.95 | 69.03 | 69.11 | 69.19 | 69.25 | 69.32 | 69.39 | 69.45 |
| 89 | 69.50 | 69.55 | 69.60 | 69.65 | 69.70 | 69.74 | 69.78 | 69.82 | 69.85 | 69.89 |
| 90 | 69.93 | 69.97 | 70.00 | 70.02 | 70.04 | 70.07 | 70.10 | 70.13 | 70.16 | 70.19 |
| 91 | 70.21 | 70.23 | 70.26 | 70.29 | 70.31 | 70.33 | 70.35 | 70.37 | 70.39 | 70.41 |
| 92 | 70.43 | 70.45 | 70.46 | 70.47 | 70.49 | 70.51 | 70.53 | 70.54 | 70.56 | 70.58 |
| 93 | 70.60 | 70.61 | 70.63 | 70.65 | 70.66 | 70.67 | 70.68 | 70.70 | 70.71 | 70.73 |
| 94 | 70.74 | 70.76 | 70.77 | 70.78 | 70.80 | 70.81 | 70.82 | 70.83 | 70.85 | 70.86 |
| 95 | 70.87 | 70.89 | 70.91 | 70.92 | 70.93 | 70.95 | 70.96 | 70.97 | 70.98 | 70.99 |
| 96 | 71.00 | | | | | | | | | |

Before entering Table I, the volatile combustible matter (V.C.M.) must be reduced to the moisture-and-ash-free basis as follows: Moisture, 11.35 per cent; ash, 13.40 per cent; total 24.75 per cent.

$100.0 - 24.75 = 75.25$ *per cent*

$$34.62 \div \frac{75.25}{100} = 46.0 \text{ per cent V.C.M. (ash and moisture free)}$$

Table I shows that the corresponding hydrogen (moisture and ash free) is 5.41 per cent. This hydrogen would amount to $5.41 \times \frac{75.25}{100} = 4.07$ per cent of the coal as received. To this must be added one-ninth of the moisture, or $11.35 \div 9 = 1.26$, making the total hydrogen in the coal as received $4.07 + 1.26 = 5.33$ per cent.

In order to find the ultimate carbon from Table II, it is first necessary to reduce the sum of the volatile combustible matter and fixed carbon (V.C.M. + F.C.) to the moisture-free basis. Then

$34.62 + 40.63 = 75.25$ *per cent V.C.M. + F.C. (as fired)*

$100.00 - 11.35 = 88.65$ *per cent dry*

$$75.25 \div \frac{88.65}{100} = 84.88 \text{ per cent V.C.M. + F.C. (moisture free)}$$

Entering Table II with 84.88 per cent, we find 66.14 per cent of ultimate carbon (moisture free) The ultimate carbon in the coal as received is, then, $66.14 \times \frac{88.65}{100} = 58.63$ per cent.

Taking 1.3 for the percentage of nitrogen on the moisture-free basis, the nitrogen in the coal as received would be: $1.3 \times \frac{88.65}{100} = 1.15$ per cent.

We now have the following estimated ultimate analysis of the coal as received:

| Element | Per Cent | How Obtained |
|---|---|---|
| Carbon | 58.63 | Figured as shown |
| Hydrogen | 5.33 | Figured as shown |
| Oxygen | 16.73 | 100.00 minus sum of all other constituents |
| Nitrogen | 1.15 | Figured as shown |
| Sulphur | 4.76 | Same as proximate analysis |
| Ash | 13.40 | Same as proximate analysis |
| Total | 100.00 | |

By Dulong's formula the heating value as received would be

$$14{,}600 \times 0.5863 + 62{,}000\left(0.0533 - \frac{0.1673}{8}\right) + 4{,}000 \times 0.0476 = 8{,}560 + 2{,}009 + 190 = 10{,}759 \text{ B.t.u.}$$

It is interesting to compare the estimated with the actual ultimate analysis of this particular coal as given in the following table:

| | Actual | Estimated |
|---|---|---|
| Carbon | 57.36 | 58.63 |
| Hydrogen | 5.41 | 5.33 |
| Oxygen | 18.02 | 16.73 |
| Nitrogen | 1.05 | 1.15 |
| Sulphur | 4.76 | 4.76 |
| Ash | 13.40 | 13.40 |
| Total | 100.00 | 100.00 |

The heating value computed from this actual ultimate analysis by Dulong's formula is 10,525 B.t.u. It is seen that both the analysis and the heating value are reasonably close to those figures derived from the proximate analysis with the aid of the tables.

---

In many plants where material is conveyed on belts, a portion of the material sticks to the belt. In order to remove these particles in many cases, rotating brushes are installed so that they brush off the under side of the belt. Such an arrangement is, however, not satisfactory, as the brush wears out the belt. In order to overcome this difficulty, an ingenious device has been developed which resembles a squirrel cage. This rig is called a "tapper" and taps the belt as it revolves. The attached particles are thus shaken off the belt without the rubbing action of a brush.

---

Fire-protection, both hose line and sprinkler, should be flushed out thoroughly at least once each year. The accumulations in such systems is astonishing.

# EDITORIALS

## Need of Refrigerating Machinery Specifications

THE average American has an inborn idea that he understands machinery and is fully capable of determining what is needed in the way of engineering materials. This has led to the too general habit of purchasing plant equipment without consulting an engineer who is qualified in the particular branch of engineering and in many cases without even a specification or written statement of what is to be furnished.

This deplorable condition is most evident in the refrigerating field. Years ago, when this industry was small, there were but few men outside the organization of ice-machine builders who understood in any great measure the machinery required for a given tonnage. The consequence was that the purchaser was compelled to turn to the seller for engineering advice. If the plant was not always all that was expected, the purchaser had little hope to do more than struggle along as best he could with the machinery on hand. If the plant cost too much, the purchaser was compelled to sell his product at a price high enough to absorb the unreasonable overhead.

Of late years engineers have become better versed in refrigeration and know what is needed to accomplish the desired results under any conditions. It is no longer necessary to buy with one's eyes shut. As discussed on another page, refrigerating equipment should be purchased only by specification. By specifying in detail the equipment wanted, both the purchaser and the seller are benefited. The former knows that he is obtaining the specified material at a fair price since the use of a liberal specification enables all builders to compete. On the other hand, the builder and seller doing a legitimate business is assisted, in that he is no longer subjected to cut-throat competitors who skimp the job in order to offer a low bid.

## The A.S.M.E. and Industrial Progress

AS THIS issue of *Power* goes to press, the American Society of Mechanical Engineers is about to start the week of intense activity which marks its forty-third annual meeting. This organization, whose membership embraces most of the leading mechanical engineers of this country and many in foreign lands, has come to occupy a position of authority not only among engineers, but also in the councils of the nation. Of all the many ways in which the A.S.M.E. serves the engineering profession and the public at large, perhaps the most important is its function as a proving ground for new ideas.

The daily work of its members in the thousand-and-one specialties of mechanical engineering throws them in direct contact with facts. This inevitably results in the production of ideas, many of which contain the germ of important industrial developments. Without the stimulus of a national organization, most of these valuable ideas would be lost to the profession or, at best, find only a limited and local application until the slow process of time had tried them out and led to their more general adoption. Fortunately, the salvaging of this priceless material is not left to time and chance. The engineer who has an idea, and the initiative and ability to give it a searching preliminary test with the facilities at his command, is practically assured of an opportunity to present it, in the form of an A.S.M.E. paper, for the consideration of his fellow engineers. Thereupon it must run the gauntlet of criticism. Is it true? Is it of practical value? Can it be improved? These are some of the tests it must meet.

If the idea proves important, it stimulates the work of other engineers until there is built up around the subject a composite engineering judgment that quickly finds practical expression in industry. If, on the other hand, the idea holds no practical possibilities, that fact is likewise made apparent to the whole profession, without delay, so that other engineers are spared the repetition of useless work.

## Plant Lubrication

IN THESE days of rapid mechanical development and great industrial plants equipped with machinery of varied construction and operating under different conditions, proper lubrication has become one of the big factors to be considered. From the older method of hit-or-miss selection of an oil, lubrication has become an exact science and trained engineers stand ready to diagnose the operating conditions and prescribe the proper lubricants for the plant and the grade of oil to use in a specific machine.

Notwithstanding the development in this field there are still many executives who fail to realize the importance of this phase of plant operation and the direct bearing it may have on the profit or loss side of the ledger. Go into the purchasing department of any large industrial plant and inquire about the kind of oil used, how it is used and the reasons for its selection. The chances are that it will be found that lubrication and possibly the entire power plant is considered a necessary evil. In too many cases the selection of the oil is left to the purchasing agent and to an engineer who has not specialized in this new science.

In direct contrast to the general attitude, the practice of representative engine builders may be cited. To the longevity of their particular machine and the efficiency of operation, they realize the importance of proper lubrication, even going so far as to send out samples of the correct grade of oil to be used with their product or the publication of instructive literature. One of the big problems is to make the purchaser of the equipment understand the importance of selecting proper lubricants, that correct lubrication means less friction and therefore more power, production at a higher rate and lower maintenance costs.

From another angle, take a large factory with hundreds of operatives at work. Suddenly trouble arises and an order comes through to lay off for the rest of the day. In tracing back the trouble, it may be

found that an engine has broken down, a bearing has burned out or some special part of an important machine has broken. In each case the cause may be faulty lubrication, and indirectly this condition is responsible for the cost of a shutdown.

It is well to bear in mind that one grade of oil brought on a price-per-gallon basis is not suitable for all kinds of machines operating under different conditions. Each machine has its peculiarities in design and construction, calling for a specific grade of oil, and in each case the operating conditions will influence the selection. Of course it is not feasible to use a different oil for every machine in the plant, but it is possible to classify the machinery and select an oil for each class that will come nearest to fulfilling all requirements.

Sharp executive scrutiny will be given to lubrication when it is realized that the correct oil lowers production costs, reduces maintenance and that a few cents per gallon saved in the initial cost may mean the expenditure of thousands of dollars in wasted power, broken parts and plant shutdowns. Scientific lubrication will pay. The modern industrial establishment cannot afford to overlook this important phase of plant operation.

## Why Procrastinate?

PROBABLY nothing could be more ridiculous than our present method of mining and transportating coal. During the summer months, when coal is most easily mined and transported, production is usually at a minimum, and in the winter, when the greatest difficulties are encountered in mining, water and railway transportation and local distribution, maximum production must be maintained to meet the demands during this period.

This condition has existed practically as long as the coal-mining industry, and little has been done toward a remedy. If this affected only one class of interests, it might not be so absurd, but it affects every one having to do with coal—the mine owners, operators, miners, railroads, distributors, and the public. The only ones that can benefit are the speculators, who profit by other's misfortunes. Is it not time for all interests to get together in an honest attempt to work out a solution?

If advantage is taken of the facts developed by the recent strike, that there is sufficient coal-storage capacity in this country to maintain a high rate of production during the summer months, and something is done to prevent a future shortage, then the strike will have at least one redeeming feature. With a miners' strike that practically tied up the coal-mining industry of the country for five months and a railway strike that seriously threatened transportation, our industrial activities were kept going without serious inconvenience.

Recommendations made recently to the Federal Coal Commission, through a special committee of directors of the National Retail Coal Merchants' Association, for seasonal reduction in mine and retail rates as well as in freight rates, offer a logical incentive for the consumer to store coal during the summer months. If the coal-mining industry is put on a basis where production is equalized throughout the year, then during periods when the mines are generally operating at reduced capacity, operations will continue and the cost per ton can be reduced. The railroads will be obtaining a revenue from their cars during a period when many of them would otherwise be idle. On the distribution end the wholesale and retailers will not only operate their equipment at a higher load factor, but also deliver a large percentage during a period when it is most easily done, consequently they can distribute at a lower cost. This can be accomplished only by an established seasonal rate for coal, making spring and summer rates low enough and the winter rates sufficiently high to make it worth while for the consumer to purchase fuel during the former period. When such rates are established and the consumer knows that the coal market is no longer a gamble as to what the price may be, much will have been done to eliminate the menace this country is laboring under due to the present conditions in the coal industry. When the miner is given an opportunity to work at a living wage for three hundred days a year instead of one hundred and fifty, he will probably think twice before he goes on strike.

## Good Work in Spite of Handicaps

AT PRESENT there is more water-power development under construction in this country than at any previous period. In fact, according to the second annual report of the Federal Power Commission, just issued, applications for permits during the last two years have totaled over twenty-one million horsepower which represents twice the existing water-power installation and over six times the aggregate of Federal applications during the last twenty years.

The factors chiefly responsible for this stimulus are a general increased demand for industrial power, the increasing cost of fuel with the periodic disturbances in supply, and lastly the formulation of a definite water-power policy on the part of the Government.

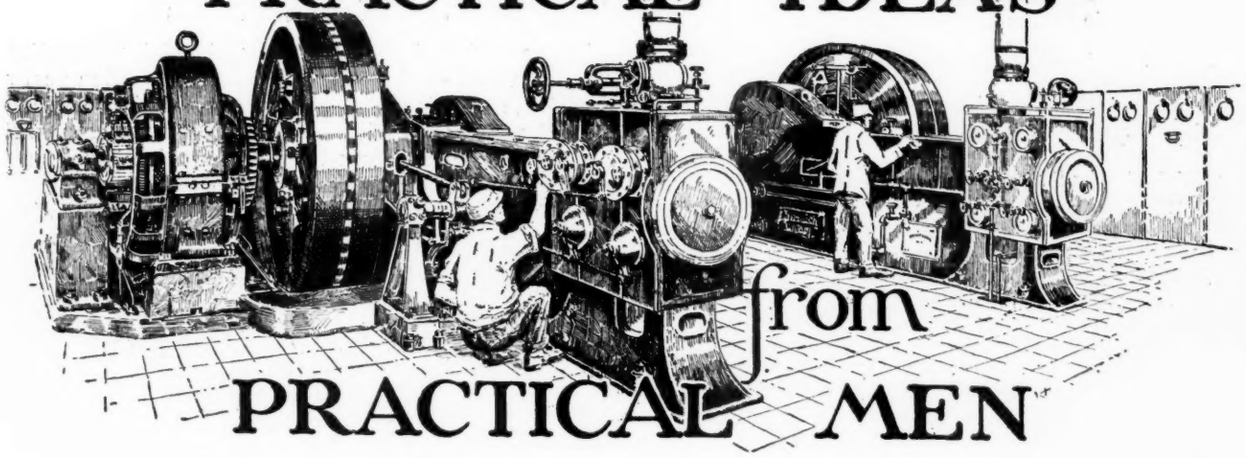
The act creating the Federal Power Commission charged that body with onerous duties, including investigation of the ability of applicants to carry out the projects; investigation of priority claims and jurisdiction; passing upon the water utilization and general structural details; the establishment of a system of accounting; and the valuations of properties licensed under the act or constructed prior to the license.

But Congress stopped with the passage of the act and failed to make provision for the personnel to carry out these duties. It provided only for an executive secretary and an engineer officer. Therefore, the commission has been forced to the expedient of functioning with a small force borrowed from other government departments. This force consists of eight engineers, two attorneys, two accountants and eighteen clerks.

That the Commission, during a little over two years, has been able to give attention to three hundred and twenty-one applications and definitely pass upon fifty-eight permits and forty-nine licenses, in spite of a totally inadequate staff, reflects credit upon its personnel and particularly the executive secretary upon whom much of the responsibility falls.

Why the Commission should thus be handicapped through an inadequate staff has been a matter of much speculation. It has been suggested that there is fear in some quarters that with increased personnel it might attempt to broaden its activities and eventually grow into a great regulatory body such as the Interstate Commerce Commission. Again it has been hinted that lack of sympathy with the whole idea embodied in the Water-Power Act on the part of at least one of the Cabinet officers making up the Commission is partly responsible. Whatever the real reason the situation is deplorable when one considers the capital involved in the projects and their relation to the further industrial development of the country.

# PRACTICAL IDEAS from PRACTICAL MEN



## What Is a Billion?

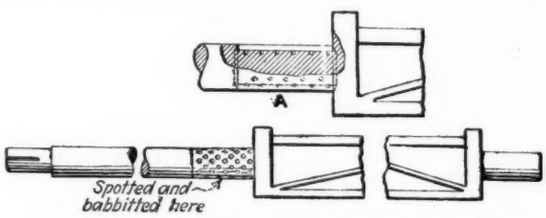
Until recently I thought that a billion was always the same as one thousand millions (1,000,000,000), but I have learned that it may mean something else. This discovery came from reading an English technical periodical where some statistics brought in the word "billion." It seemed impossible to check the figures given, so I finally looked up the word "billion" in the dictionary and found that it had two different meanings. In America and France, according to this authority, it means one thousand millions, whereas, in England, the Spanish-speaking countries and most European countries it means a million millions. In the same way a trillion according to the American system is 1,000,000,000,000; whereas, according to the English system, it is 1,000,000,000,000,000,000.

I believe this fact is not generally known to Americans, engineers or otherwise. To know it may save confusion when reading foreign papers.

Philadelphia, Pa. H. K. STEADWELL.

## Building Up Worn Valve Rod with Babbitt

While overhauling one of our Corliss engines some time ago, we found the exhaust-valve rods badly worn where they operate in the stuffing boxes. To replace




ROD IS TURNED DOWN, SPOTTED AND BUILT UP WITH BABBITT

these rods with new ones would have entailed considerable time and expense, so it was decided to repair them.

This was accomplished by turning down the worn part to a depth of $\frac{1}{4}$ by $3\frac{1}{2}$ in. in length, as shown in cross-section at *A* in the cut. This area was then spotted with $\frac{1}{4}$-in. holes spaced $\frac{3}{4}$ in. apart and staggered all around the rod.

A sleeve $\frac{1}{4}$ in. larger in internal diameter than the rod was then placed over the part to be babbitted and the bottom sealed with clay. After the babbitt was poured, it was allowed to cool, than peened and turned to the original size of the rod. This repair proved satisfactory and is giving good service. W. A. FORD.

Helmetta, N. J.

## Conditions and Operating Results of Two Ice Plants Compared

It is sometimes surprising how much abuse a steam plant can stand and yet give fairly good service. I had occasion some time ago to be connected for a short time with an ice plant that had been in use for several years without any regular engineer. When the plant was shut down in the fall, no precautions were taken to protect the equipment during the out-of-service period, not even to draining the pipes. When they were ready to start up in the spring, they patched up the damage from bursted pipes and machinery and went ahead from where they shut down in the fall. They hired the first fellow that happened along who could heave a little coal in the firebox and squirt a little oil at the engine.

There were three or four pumps in service and as many more around the plant that had been allowed to freeze up and burst.

The ammonia compressor was a horizontal steam cylinder unit, with vertical single-acting gas cylinders. This was the only machine in the plant that was in fair condition, and nothing had been done to it for several years except the packing of the rods and valve stems.

The boiler plant consisted of two horizontal return-tubular boilers; both had been bagged and were patched. The scale had accumulated on the tubes at the rear head until the beading was nearly all burned off and most of the tubes were leaking. One tube was capped on each end with a rod through it, but could not be kept from leaking. This boiler was fired up long enough to blow the other boiler down and wash it and put it on the line again. No pipe covering was used in the plant either on steam or ammonia lines. The brine-circulating pump was connected up in such a way that the discharge pipe had to be disconnected before the brine plungers could be packed. No stop valves were provided on either the supply or return lines. The whole system had to be drained before any work could be done on the pump. Some idea of the poor condition

of the plant was evidenced by the fact that it took almost 1½ barrels of oil to produce a ton of ice.

I had occasion some time later to visit another plant of about the same capacity and age, but where the equipment was in first-class condition and a competent engineer in charge. On entering the plant, one was immediately impressed with the appearance and smooth operation of all the equipment. The plant was operating efficiently and was producing a ton of ice on one-half barrel of oil.

The comparison of these two plants and the results obtained from them might furnish some food for thought, and in my opinion they prove beyond question the advisability of employing a competent engineer and holding him responsible for the successful and efficient operation of the plant. DELL E. GATE.

Cleveland, Ohio.

## Cutoffs with Varying Valve Travels

To find where average cutoff occurs with a D valve at various travels, construct a scale or diagram as shown in the cut. On a line *AB* 6 in. long draw the equi-distant concentric quadrants at the left-hand side, with ⅛-in. increments of radius; and at the right-hand end, with ¼-in. increments of radius. Mark the close-spaced ones "Valve-Travel Curves" or "Eccentric Paths." Mark the others with the actual diameters on a ¼-in. scale, and call them "Crankpin Paths."

To find, for instance, at what point in the crankpin path and piston stroke in a cylinder with 18-in. stroke cutoff occurs with, say, ¾-in. steam lap, when the travel of the valve is 5 in., lay a straight-edge from *C*, one end of the 5-in. valve-travel quadrant, tangent to the quadrant with actual radius ¾ in., and note where it cuts the 18-in. crankpin path (at *E*). That is, the crankpin position at cutoff. Using a 90 deg. triangle, drop a perpendicular from *E* to *AB*, then the point *P*, where it meets *AB*, represents the corresponding wristpin position at cutoff with 5 in travel. *CP* represents average admission period, *PR* average expansion period, neglecting lead and exhaust lap.

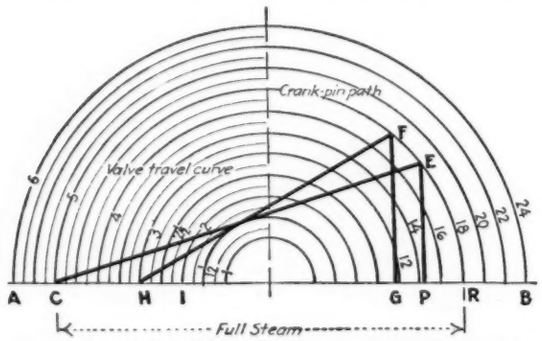



DIAGRAM SHOWING METHOD OF FINDING POINT OF CUTOFF WITH DIFFERENT VALVE TRAVELS

For 3 in. travel with the same lap and piston stroke, draw the tangent from the 3 in. travel quadrant at *H*, to the same lap circle as before, prolonging it until it cuts the 18 in. crankpin path at *F;* drop the perpendicular *FG*; then cutoff takes place when the crankpin and the wristpin are at *F* and *G* respectively.

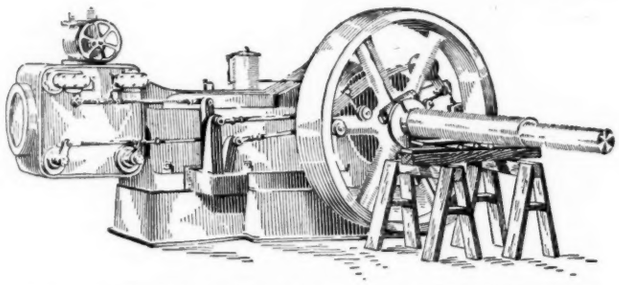
The influence of connecting-rod length is not considered in this connection, because correction therefore is usually made to equalize compression and release, only.

New York City. ROBERT GRIMSHAW.

## Lining Up an Engine Without the Use of Center Lines

I have noticed from time to time inquiries regarding the best way to line up an engine, and from ten years' experience in this class of work, suggest the following method which if carried out with the usual care, will in many cases make a considerable reduction in the time and expense, ordinarily required to do this work.

First, level up the engine frame for final setting and then place the shaft in position, allowing the outer



BY SUPPORTING ON ROLLERS AND TIGHTENING UP MAIN BEARING, THE SHAFT IS MOVED INTO CORRECT ALIGNMENT

end to rest on an iron bar, supported on rollers as shown. This allows the end of the shaft to move freely. Now carefully level the shaft to the main bearing of the engine and pull the quarter-boxes up snug. This will throw the shaft at right angles to the center line of the cylinder without the necessity of removing the cylinder head and placing a line through the cylinder, which is the usual practice. Finally, set the outboard bearing to the shaft in this position, and the lining up is complete and the result will be as good as if not better than could be obtained by lining up with a line through the cylinder. H. R. ROCKWELL.

St. Louis, Mo.

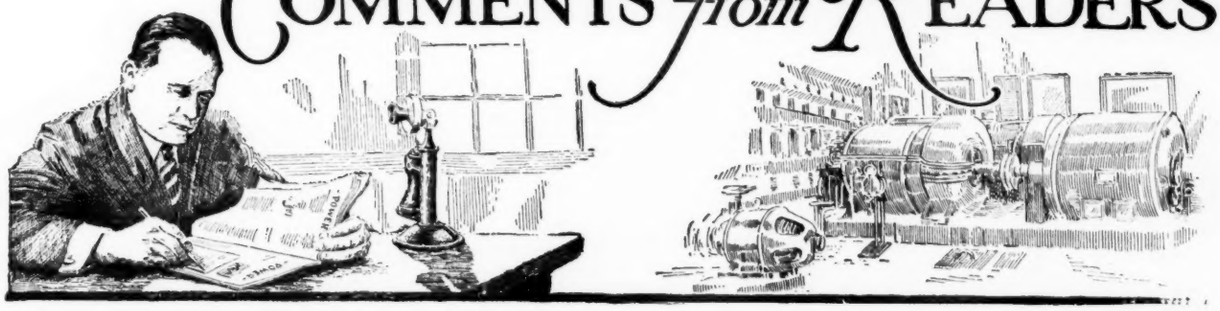
## Feed Water Catches Fire

Several years ago, when in charge of the power plant of an oil refinery, I had a rather peculiar experience. The turbine ran non-condensing and the exhaust was used for treating oil in the steam stills. The condensation was then trapped out in the receiving house and returned by gravity to the feed-water heater. Some gasoline was also trapped, and a special trap in the line took care of this.

One day this water line, which ran underground part of the way, was found in need of repairs, and in order to facilitate the work of the pipe crew, I instructed the fireman to pump the water from this line after cutting off the supply in the receiving house. I then left on some business at the main office. A few minutes later there was alarm of fire and rushing back to the boiler house, I found that the firemen had neglected to stop the pump when all the water was out, and considerable gasoline had been drawn through the line and discharged into an open conduit in front of the boilers. The vapors from the gasoline were being drawn up through the ashpits of the boilers by the draft, and a hot fire of rather mysterious origin to most of the employees raged for a few minutes until the pump was shut down. V. R. CHADBOURNE.

Beaumont, Tex.

# COMMENTS from READERS



## Trouble from Water Leaving Heating Boiler

In the Nov. 14 issue P. R. asks why the water in the gage glass of a sectional heating boiler goes out of sight when the steam pressure is raised to 4 or 5 lb. In my opinion the answer given does not completely cover this question. There are many boilers where the gage glass is tapped into the section close to the top for both water and steam connection, and it is not uncommon to find the water entirely disappearing from the glass in such boilers, when the water line in the boiler has actually changed only a small amount. This can be overcome by tapping in the lower water-column connection at or near the bottom of the boiler.

This, however, may not be the trouble in this particular case. I have found that under certain conditions the water will leave the boiler, and with a reduced pressure return to the boiler. The reason for this, I believe, is that the distributing piping is large compared to the water space in the boiler, and in order to fill all the piping, radiation, etc., with steam, more water is required than exists in the water space in the boiler. The only method of overcoming this difficulty is to install a boiler with a larger water space.

Boston, Mass. HENRY D. JACKSON.

## Public Interest in Combustion

I read with a great deal of interest in the Sept. 26 issue the editorial on "Public Interest in Combustion," and to the views expressed therein, I think every engineer will assent.

So far as our local conditions are concerned, not one of the appointees has had practical experience in the work. For instance, the local head is the superintendent of the Humane Society and his appointees are the cashier of a bank, a doctor, a lawyer, etc. Combustion engineers? Yes, there are those who have studied and read and practiced in the profession and who right now should be the ones to direct, but so far as I know, not one has been so appointed.

The coal problem is largely a farce and has been, and is backed up by the government with a license to rob us. There are no standards for either quality, ash or carbon, or in fact anything—hardly for weight. Foods are supposed to be sold by weight or measure; drugs the same; cloth by the yard. Almost everything else has some standard. Even the water we use is metered. But coal, the thing most important to all, poor and rich alike, has absolutely none. It is simply, "take it or leave it as you like, but at my price if you do."

It is little short of a crime, and right now, instead of being able to get it at the same price as before the strike (or less as promised), the poor consumer has to settle for all delays and make good the lost time and alleged losses with a good addition for doing business.

Steam coal has been steadily going down in size and quality for the last eighteen years while to my knowledge the price has nearly trebled and still we are supposed to make good.

What has the government done or what is it doing to help us now? Why not get this coal problem going and all of us get after it? As it is, we are robbed and systematically so by those licensed to do it.

Binghamton, N. Y. A. P. HYDE.

## Importance of Fundamental Principles

The article on the compound gas engine in the Oct. 10 issue brings to mind the attempt to design and build a compound gas engine, by an engineer who was lacking in a knowledge of the thermodynamic and mechanical principles on which the compound steam engine gains in economy over the simple engine. He thought that if steam could be used over again advantageously in a second cylinder, why not gas? He did not have in mind intercooling during compression, as is advocated in the article referred to; he was simply going to carry the expansion out in two cylinders on the supposition that there would be a gain in economy just as in a steam engine. Needless to say, his compound gas engine was never completed.

The thermal advantage of compounding in the steam engine being due to the decreased cylinder condensation where the total heat range is divided up in two or more stages, it is evident that there can be no corresponding advantage in compounding in the gas engine, as there are no condensation losses to overcome.

Another engineer, who was in charge of a small electric plant, could not see how the sudden breaking of a field circuit of a generator could put a voltage strain on the field coils. I think a good many are a little hazy on this point. A more careful study of self-induction and its effects would make it all plain.

In electricity, especially, one should first get a thorough understanding of elementary principles. A beginner finds it hard to see any connection of some of this study with his practical work, but he will never understand the "how" and the "why" of his work unless he takes the time to study the elementary principles thoroughly, no matter how irrelevant they may seem to every-day work.

A knowledge of mathematics and physics forms the foundation for the study of engineering, and it is use-

less to try to avoid these subjects if one expects to get very far. A knowledge of algebra will help one to use formulas intelligently. A knowledge of trigonometry is almost necessary to a thorough understanding of alternating currents. Nearly all the literature on the subject explains certain voltage and current relations by means of trigonometry, and the man unacquainted with this branch of mathematics finds himself handicapped in his study of alternating currents.

If some of our would-be inventors would study physics carefully, they would probably learn something about the law of the conservation of energy, and we would not have our annual crop of perpetual-motion devices, and the inventors and investors alike would profit by this knowledge of the laws of nature.

Do not slight the fundamental principles of any subject. H. G. ROBERTS.

Seattle, Wash.

## Welding Tubes Into the Tube Sheets of Boilers

In the Oct. 24 issue L. Johnson asks several questions regarding welding tubes into the tube sheets of boilers, as described in an article by Fred H. Williams in the Oct. 10 issue.

As Mr. Williams dealt with this subject in a technical manner, the same questions doubtless occur to other readers, who may not be familiar with locomotive practice. To those who are, the reasons for welding tubes into the tube sheets are well known, as this practice is not new.

Mr. Williams might have gone further and enumerated many other uses of electric-arc welding, such as building up worn and sharp-wheel flanges, worn and undersized wristpins, crankpins, etc. It is indeed common practice to use the electric arc for welding fire cracks in the firebox sheets or for building up wasted or corroded portions of the sheet. Answering Mr. Johnson's questions in order:

First: Tubes are welded to the sheet to keep them from leaking; once properly welded into a tube sheet, they give little if any trouble from leaks until the entire set requires renewal.

Second: The heat of the welding arc being local, severe stresses are not set up either in the sheet or tube.

Third: By careful examination, welds of this kind have been under my personal observation for more than three years with no signs of cracks or leaks.

Fourth: Use a tube cutter that cuts the tube off inside of the tube sheet, then reaming the hole in the tube sheet to normal size, thereby removing the end of the old tube. In doing this, it is necessary to remove and clean off all metal previously deposited in welding.

Fifth: Following the foregoing practice of removing tubes, I have replaced as many as four tubes in the same tube hole and without visible injury to the tube sheet. Should the hole in the tube sheet become unduly enlarged after repeated replacement of tubes, it may be decreased by filling in metal with the electric arc welder and afterward boring or reaming to the desired size.

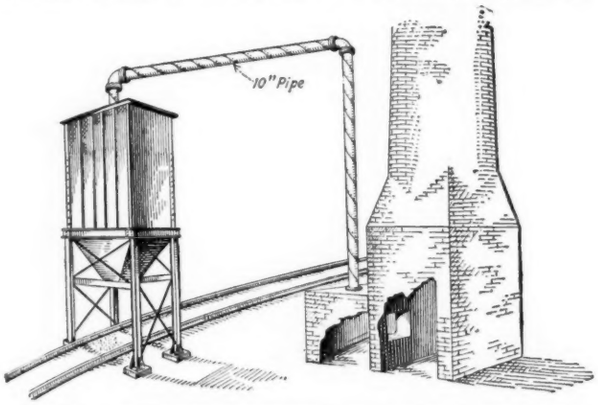
It must be remembered that, owing to the small size of the arc produced, the heat, while intense, is localized, hence the small probability of severe temperature stresses occurring after the weld has cooled. As an example of what is done with this class of welding, I refer to the case of a weld in the crownsheet of a locomotive boiler where the crack was originally 32 in. long, but after repeated attempts at gas welding had increased to 44 in. In preparing the metal for the electric weld, it was necessary to remove so much carbonized metal that the opening, before welding was begun, was 3½ in. wide by 44 in. long. This entire weld was located at the angle where the crown sheet joins the side sheet, and the entire opening was filled with metal deposited by the electric-arc method. This boiler has been in service for eight months carrying 175 lb. pressure without leaks or signs of distress.

So far, my experience has covered tubes welded in the firebox end only, and I would like to see the experiences and observations of others related in the columns of *Power* for the benefit of everybody concerned, whether they are railroad men or not. H. R. WASS.

St. Louis, Mo.

## Eliminating Ash Dust with Jet Conveyors

In a letter in the Oct. 10 issue W. B. Trott asks for some suggestions as to an effective way of eliminating ash dust with steam jet ash conveyors. We experienced the same trouble at our plant, but overcame it by running a 10-in. spiral galvanized iron pipe from the top of the ash bunker over the roof of the boiler house and




BUNKER VENT IS CONNECTED TO BOTTOM OF STACK

connecting it to the bottom of the smokestack through a small compartment built at the base of the stack, as shown in the cut.

This arrangement has given good results and makes the use of water sprays unnecessary.

Dover, N. J. R. H. AHLERS.

## What Caused the Black Spots on the Commutator?

In response to the request of Mr. Macrea in the Oct. 21 issue for suggestions as to the cause of black spots forming on the commutator, I am of the opinion that these are caused by heavy cross-currents flowing through the machines due to their operating at different frequency. Machine No. 3 produces 2,800 alternations per minute, while Nos. 1 and 2 produce 2,550 alternations per minute. Therefore the alternating currents generated by the machines are not in step with each other.

The trouble may be stopped in two ways: By changing the speed so that they operate in step; or, if this cannot be done, disconnect the balance coils from the slip rings and use a three-wire balancer set to obtain the neutral for the three-wire system.

Cody, Wyo. A. S. MCCLAIN.

## Water Rates of Unaflow Engines

I have read with interest the account of the Hoover Suction Sweeper's plant in the Nov. 14 issue, but noticed what appears to be a mistake. On page 754 the water rate of the unaflow engine driven units is given at from 19 lb. to 21.4 lb. per kilowatt hour, and for non-condensing units, this is remarkable. Should not these water rates be per indicated horsepower hour and not per kilowatt-hour?

For similar plants the writer is advocating unaflow engines running non-condensing during the winter months for heating, and condensing with multijet condenser and spray pond or cooling tower during the summer months. By this means the over-all cost of heat and power can be reduced below the possibilities either with purchased power or with purchased power in the summer and generated power in the winter, bearing in mind the standby charge made for the service during the winter months, even though no current is used.

Such a unaflow-engine proposition with condenser and spray pond or cooling tower should be the proper solution for thousands of small plants.

Boston, Mass. F. S. BROADHURST.

[Mr. Broadhurst is correct in his assumption with regard to the steam rate of these units. This should have read pounds of steam per indicated horsepower and not kilowatt-hour as given.—EDITOR.]

## Feed-Water Problems

The principal problem presented by boiler feed water in most of the plants in this country is the elimination of scale-forming impurities. Certain plants in the Middle West have to deal with alkali water, which on concentration causes excessive foaming. Large central stations using pure condensate with little makeup, have trouble due to oxygen in solution in the feed water. It is standard practice in plants with scale-forming salts or alkali in the boiler feed to blow down the boilers at frequent intervals. This, of course, means a loss of considerable heat. Most of the newer power plants are designed with equipment to keep the feed water relatively free of oxygen and scale-forming impurities, so that blowdowns may be avoided and heat thereby conserved.

The recent article by Adams and Hoots on "Solving the Feed-water Problem at New Orleans," published in the Oct. 17 issue of *Power*, directs attention to another phase of this problem. In discussing the conditions at the New Orleans plant, the authors point out that the softening process and its reactions may remove the scale-forming impurities from the feed water, but add in their place certain soluble sodium compound practically equal in quantity to the scale-forming materials removed. These are due partly to the chemical reactions in the soda-lime process, partly to the excess of soda that must be used and partly to the sodium impurities in the raw water. The quantity of makeup is evidently large, and as a result the concentration of the water in the boiler soon became excessive and foaming occurred. This caused small particles of water to be carried over into the superheater, reducing the superheat and forming in the superheater a fine white soda scale. This scale caused trouble by stoppage of tubes and by superheater tube failures, but a major portion was carried along with the steam and deposited on the walls of the steam lines and on turbine blading.

The trouble was remedied by blowing down the boilers at regular periods to keep the concentration low. Obviously, much heat was wasted by these blowdowns. In view of these experiences the idea suggests itself that water softening alone will not remedy all feed-water troubles and that engineers will have to provide some further means to meet these difficulties.

It seems reasonable that the best remedy would be to keep all impurities of every character out of the feed water and out of the boiler, or in other words to feed only distilled water and pure condensate. This can be done at the present state of the art only by the employment of evaporators and tight condensers. There is a real need for a cheap, simple, effective low-pressure evaporator, in small as well as large sizes, that would be suitable for this work. Present types are generally too expensive, and the high-pressure type wastes potential heat that might be utilized in power development. It is time that manufacturers gave attention to this large and rapidly developing demand. Improvements can still be made in condenser design, for even the best is prone to leak in service and this introduces impurities into the feed water.

Baltimore, Md. A. G. CHRISTIE.

## What Caused the Bearing to Heat?

Referring to E. Wotring's letter on page 733 of the Nov. 14 issue, I am of the opinion that his trouble is due to stray currents flowing through the oil film in the bearing; at least, the facts, as reported by him, seem to indicate that this is the case. The oil film has such a low resistance that it is sometimes difficult to be positive that current is flowing. The amount of current varies with the design of the machine, local conditions, etc.

In some cases, where there are duplicate machines in a power house, one of them will show shaft currents when the other one does not. The first indication of these shaft currents is the discoloring of the oil. In some cases babbitt is actually pitted out of the bearing lining and deposited on the shaft.

Sometimes these currents can be detected by means of a direct-current ammeter connected to the bearing pedestal and then to a large copper-gauze brush held firmly against the end of the shaft when the machine is running. The voltage, at the most, is only a few millivolts, so this test depends on having a low resistance meter and on getting almost perfect contact with the bearing pedestal.

Rather than spend much time or money in trying to locate the currents, I recommend that he insulate the bearing pedestal. This can be done by replacing some of the shims between the bearing pedestal and the base with a corresponding thickness of horn fiber. The bolts and dowel pins holding the pedestal to the base can be necked down between the thread and the head and wrapped with mica tape and insulating varnish or, failing this, with tough paper and shellac until they are back to size. Fiber, hard rubber or pasted mica washers can be used under metal washers between the top of the pedestal and the bolt heads. The voltage is only a few millivolts, so that almost anything that is mechanically strong enough will serve as insulation.

General Electric Co. N. L. REA,
Schenectady, N. Y. Construction Engineer.

# QUESTIONS AND ANSWERS

### Velocity of Discharge Through 12-in. Pipe

What would be the velocity (feet per second) of water discharged through a 12-in. diameter pipe inserted at the base of a dam with the head of water 25 ft.? B. J. B.

The average velocity would depend on the shape of the inlet end of the pipe, the length of pipe, roughness of the pipe surface and also the pressure against which the discharge takes place. The theoretical velocity in feet per second would be 8.03 times the square root of the head 25 ft., or 40.1 ft. per second. For a straight clean pipe 2½ to 3 times as long as diameter the average velocity would be about 81 per cent of the theoretical, or 81 per cent of 40.1 = 32.48 ft. per second.

This provides that the pipe is uniform in diameter for its full length, that the entrance end is cut off square, that the length of the pipe is 2½ to 3 times the diameter, and that there is no obstruction of free flow to the entrance tending to reduce the head of 25 ft. at the entrance.

With a bell-shaped mouth at the entrance of the pipe, the velocity in a short pipe would be nearly the theoretical, and for a longer pipe than three times the diameter, the velocity and discharge would be reduced, depending on the size, length and roughness of the interior of the pipe. Velocities, discharges and losses of head in pipe lines are given in Weston's "Loss of Head due to Friction of Water in Pipes" and Williams and Hazen's "Hydraulic Tables."

### Surging in Turbine Valve Gear Due to Friction

We are troubled at occasional intervals with surging in the valve gear of a steam turbine. The operation is satisfactory nearly all the time, but when this turbine is started up on Mondays for the week's run, we occasionally have some violent surging or hunting of the valve gear, which lasts for a short time only. This is an oil-hydraulic system, and a new pilot valve has recently been installed. When shut down after the week's run, we tried it to see if there was any sticking, but the pilot valve moved. What causes the surging? W. E. F.

The trouble which has occurred since installing the new pilot valve is probably due to friction, although the source is not apparent. When the turbine is started up on Monday morning, in a cold condition, the oil is quite heavy and there may be a small amount of friction due to the close fits and thick condition of oil. After being in operation for some time, the oil becomes thinner and the pilot valve may expand in such a manner as to reduce the friction so there would be no sticking in the pilot valve after shutting down the hot machine. We would suggest that you take off a small amount of the diameter of the plunger. Use a fine grade of emery cloth and remove less than 0.001 in.

If the plunger can be rotated in a lathe, application of No. 00 emery cloth saturated with oil, for a few seconds, may be sufficient. The fitting should be done when the turbine is cold, and all emery should be carefully cleaned from the stem by polishing with heavy paper or a rag. It is probable that the trouble can be removed in this manner with little difficulty.

### High and Low Duty and High- and Low-Service Pumps

What is the difference between a "high-duty" and a "low-service" pump, and could a low-service pump be used for boiler-feeding purposes? P. F. H.

The term duty, applied to a pump, refers to the economy, and the terms high or low service are of only local significance respecting relatively higher and lower pressures pumped against.

Direct-acting steam pumps are classified as low-duty when the steam is admitted the full length of the stroke as in the ordinary boiler-feed pump; and high-duty when operated with the steam cut off at an early stage of the stroke and it does useful work by virtue of its expansive force, regardless of whether the economy is actually high or low, and also regardless of the pressure pumped against.

"Light-service," sometimes designated "low-service," pumps are intended for tank supply and similar uses where the head or pressure pumped against does not exceed 50 to 75 lb., and the ratio of the steam to the water pistons is such that liquids may be raised to moderate heights with the low steam pressures which are frequently encountered in small isolated pumping equipments.

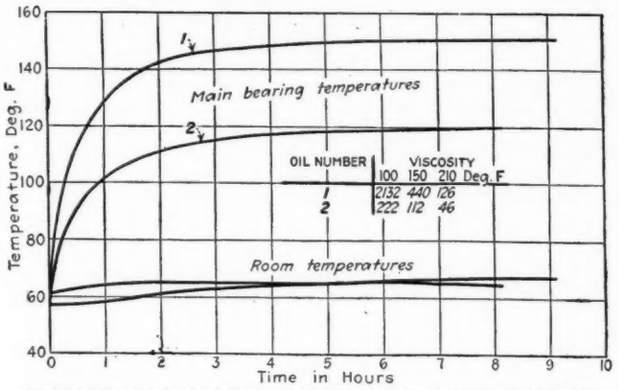
These pumps usually are made with a ratio of water to steam piston area of 0.5 in the smallest sizes to 1.25 or more in the largest sizes, according to the steam pressure available and required service pressure.

A tank or light service pump is unsuitable for boiler-feed purposes for power boilers, because the water end usually is not strong enough to withstand the necessary pressure, and on account of the small size of steam piston as compared to the size of water piston, a light-service pump of usual proportions would be unable to operate against the pressure of the boiler from which the pump receives its supply of steam in addition to the pressure required for overcoming friction, unless the pressure of the suction water was nearly as much as the boiler pressure.

### Effect of Viscosity on Oil-Engine Bearing Temperature

What influence has an oil's viscosity upon the temperature of the bearings of an oil engine? R. L. C.

If the oil will flow through the oil piping, the viscosity determines the temperature at which the bearing will run. Any oil will cause the bearing temperature to rise until it reaches a point where the heat taken away equals the frictional heat. The bearing will then operate continuously at this temperature. The lower




EFFECT OF VISCOSITY ON BEARING TEMPERATURE

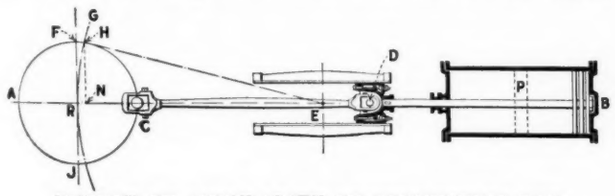
this viscosity the lower will this temperature be; this is for the reason that a thin oil will flow more readily and a greater amount will reach the bearing per minute, consequently there will be a lower temperature gradient than in case of a viscous oil. The behavior of two oils is shown in the illustration.

### Angularity of Connecting Rod and Its Effect on Equality of Cutoff

What is meant by angularity of the connecting rod of an engine, and what is the effect of angularity on the equality of cutoff in opposite ends of the cylinder? R. N. H.

The term angularity of the connecting rod refers to the varying angle that the center line of a connecting rod of finite length makes with the center line of the cylinder. The effect is illustrated in the figure.

Starting from dead-center position, head end, it may be seen that when the piston is at *P*, halfway through its stroke, the crank cannot be 90 deg. in advance of the head end dead center. If *AB* is the cylinder centerline, *CD* the length of the connecting rod, *RC* the length of crank and *CFAJ* the circle




EFFECT OF ANGULARITY OF CONNECTING ROD

described by the crank, then *AC* will be the length of stroke. If *E* is the position of the crosshead pin when the piston is at half stroke, as *RC* = *ED*, the distance *RE* would be equal to *CD*, the length of the connecting rod.

In the right angle triangle *ERF* the side *RE*, which is the length of the connecting rod, is less than the hypothenuse *FE* and therefore when the crosshead pin arrives at the half-stroke point *E*, the crank pin is not carried around to the 90 degree position *F*.

If with *E* as a center an arc is struck with radius of *ER* = *CD*, then *H*, the point where this arc intersects the crank circle, will be the position of the crankpin center when the piston is at half stroke, and the distance *NC*, from the foot of a perpendicular dropped from *H* upon *AB*, would be equal to the horizontal movement of the crank for half stroke from the head end, and *AN* would be the horizontal movement of the crankpin for half stroke from the crank end.

On account of the angularity of a connecting rod of finite length, any fraction of stroke from the head end results in less angular rotation and less movement of the crankpin in the direction of the stroke than for an equal fraction of the stroke from the crank end, and the relative motions of the crankpin and piston will be less harmonious the shorter the length of the connecting rod in proportion to the length of the crank.

In practice the connecting rod usually is four to eight times the length of the crank, and, from angularity of the connecting rod, the inequality of crankpin movements for the same fraction of stroke from opposite ends of the cylinder is considerable. Hence for cutoff obtained with a valve travel that is nearly harmonious with the angular movement of the crankpin and eccentric, as angularity of the connecting rod results in less rotation of the crankpin during a stroke from the head end, to obtain equality of cutoff in opposite ends of the cylinder it becomes necessary to hasten the cutoffs for strokes from the head end by giving more lap to the valve on the head end than on the crank end.

### Circulating Water for Diesel Engine

What amount of water is required to be circulated per hour in a Diesel engine? W. L. M.

The water required may be calculated from the formula,

$$W = \frac{W\,H}{100\,(t_1 - t_2)}, \text{ where}$$

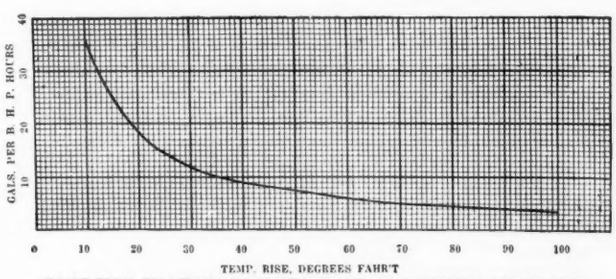
$W$ = Weight of water required per horsepower hour;

$X$ = Percentage of heat of the fuel absorbed by the water;

$H$ = Total heat supplied to the engine and is equal to pounds of fuel consumed per hour times the heat content of the fuel (about 18,500 B.t.u. per lb.);

$t_1$ = Discharge temperature of water, deg. F.;

$t_2$ = Inlet temperature of water, deg. F.




COOLING WATER REQUIRED FOR DIESEL ENGINES

The value of $X$ depends on the type and condition of the engine, but will range from 30 to 40 per cent.

In the chart are shown the water that will ordinarily be used in an engine in good condition and the cooling system should be designed in accordance.

# Chronological History of Stoker Development*

By A. H. BLACKBURN
Chief Engineer of the Under-Feed Stoker Co. of America

### Underfeed Single-Retort Stokers

1838—*Jukes* (English). Jukes patented a stoker in which the coal was thrown into the hopper and dropped down in front of the ram. By means of a hand screw the coal was fed in under the center of the grates beneath the burning fuel above it.

1844—*Frisbie* (American). Frisbie brought out and patented a stoker in which the fuel was fed from under the grates through a center opening.

1889—*Evan William Jones* (American). Evan William Jones invented and brought out the first underfeed stoker that proved successful, and he can be considered the originator of the underfeed principle, as he carried it forward to a success.

The paper mills in Oregon at that time were using green wood for fuel, difficult though it was to burn, owing to the moisture it contained. Jones, who at that time was president of the Union Iron Works at Portland, Oregon, was engaged to find some means to dry this fuel economically. The result of his study of the subject was a device for feeding sticks of green wood, in cordwood lengths, under a bed of burning fuel. The heat from the fire above dried the wood below, and as successive lengths of wood were fed under, the dry wood was advanced upward into the fire zone. In the first stoker the wood in four-foot lengths was fed in on upward-inclined grates by means of a manually operated ram. A steam cylinder was next used to operate the ram, the actuation of the valve being manual.

The success of this stoker led Mr. Jones to apply the same principle to burning coal. The grates were replaced by a retort, having dead plates on each side, from which ashes and refuse were cleaned. Tuyeres were placed along the edge of the retort, through which air was supplied to the fuel under pressure from a fan. This is the stoker manufactured by the Under-Feed Stoker Company of America today, and is the origin of all the types of underfeed stokers in this country.

1898—*W. R. Wood.* In this year Mr. Wood took out a patent on a stoker with a screw feed in place of the steam ram employed by Jones. This was known then as the American stoker. From 1901 to 1906 and 1907, Mr. Wood took out other patents on rocking bars in place of dead plates, and on side dumps. Later on he adopted the steam ram in place of the screw feed, and the final development of his original patents is the Type E stoker, manufactured by the Combustion Engineering Corporation.

1916—*J. H. Roach.* The Roach Stoker Co. entered the market with a patented stoker of similar design to the Type E, both of them using the steam cylinder for pushing in the fuel, as in the early Jones stokers.

1916—*Moloch Stoker Company.* In this year the Moloch Stoker Co. brought out a device which was similar in design to the Standard Jones stoker, but instead of using dead plates, a clinker grinder was placed between the retorts.

1917—*The Jones Side-Dump Stoker.* The Under-Feed Stoker Co. converted its standard stoker into a side-dump type, still maintaining the original principles of the former, however.

1917—*The Detroit Stoker.* The Detroit Stoker Co. brought out a stoker on the principle of the Jones, using a mechanical drive in place of the steam cylinder and substituting side dumps for the stationary dead plates.

### Underfeed Multiple-Retort Stokers

1876—*Holyrod-Smith* (English). The Smith stoker was probably the first underfeed stoker to be used commercially and advertised. It was on the market a short time, however, and soon went out of use.

1903—*E. E. Taylor.* Taylor, seeing the opportunity and the field for stokers of greater capacity, conceived the idea of the multiple-retort stoker. The first stokers of this type were manufactured by the American Windlass Co., of Providence, R. I., which company later reorganized under the name of the American Engineering Co., Philadelphia, Pa.

Taylor's first patent was taken out late in 1904 and his stoker embodied the fundamental principle of a continuous fuel bed supported by legs of coal in multiple underfeed retorts. The patent claims also cover an inclined fuel bed, with the delivery of ash to the rear of the stoker, and the method of air distribution employed. Taylor was the first to use the crank drive. R. Sanford Riley in 1909 designed the first extension grate at the end of the retorts for the Taylor stoker.

1911—*R. Sanford Riley.* Riley made application for his patent, and subsequently started manufacturing and marketing the stoker that bears his name, the distinctive features being the moving sides of retorts and tuyeres.

1912—*Westinghouse Electric and Manufacturing Company.* The multiple-retort stoker brought out by this company was similar in design to the Taylor stoker, the difference being mainly in the angle of the ram, the bottom of the retorts, and the design of the tuyeres. Their stoker is driven mechanically.

1916—*Jones A-C Stoker.* The Under-Feed Stoker Company of America brought out a multiple-retort steam-driven stoker, using the general design and principles of their standard single-retort stoker and avoiding all moving parts in the furnace.

1919—*Detroit Stoker Company.* This company brought out a multiple-retort stoker in this year, which is similar inside the furnace to the Jones A-C, except that the retorts are laid flat instead of being at a slight angle; the rams, however, are driven by a specially designed mechanical drive instead of by a steam cylinder.

1919—*Frederick Stoker.* The Frederick stoker is very similar in design to the Westinghouse, Taylor, and Riley stokers, and is now being manufactured by the Combustion Engineering Corporation.

### Underfeed Lateral-Retort Stokers

1918—*H. E. Kleffel.* Mr. Kleffel was granted a patent embodying the idea of a lateral retort.

1919—*Blackburn and Armstrong.* This stoker consists of a central retort placed longitudinally through the center of the furnace and feeding coal to lateral retorts branching out at right angles. The design is novel, and the stoker is manufactured by the Under-Feed Stoker Company of America.

### Overfeed Inclined-Grate Stokers

1845—*Hall* (English). This stoker was probably the first to employ inclined reciprocating grate bars onto which the fuel was pushed. It was brought out by Samuel Hall in England.

1867—*Vicars* (English). This stoker is still manufactured in an improved form in England, but the points that are most interesting about it are that not only were inclined grates used, but the coal was fed by a plunger or ram, this being practically the first stoker in which that was done.

1878—*Thomas Murphy* (American). Mr. Murphy brought out in this year his inclined-grate stoker of the inverted or V-shaped type. The grate bars have a reciprocating motion, and the ash is gradually worked down from the center to a clinker grinder. Mr. Murphy was undoubtedly the first to employ a clinker grinder with mechanical stokers, using in some cases one breaker and in others two breakers working together. These stokers are being manufactured by the Murphy Iron Works, of Detroit, which is probably the oldest stoker concern in the country still manufacturing stokers having the same basic principle as those they first built.

1885—*William R. Roney.* Roney brought out the front inclined-grate stoker and was the first one to make a distinct

*To be presented before the American Society of Mechanical Engineers, New York, Dec. 4 to 7, 1922.

success with this type in this country. It is manufactured and sold by the Westinghouse Electric & Manufacturing Company.

1890—*Wilkinson Stoker.* This is a front inclined stoker, but varies from some of the others in that steam jets are used to draw air through hollow grate bars. It was designed originally for burning small sizes of anthracite.

1897—*Detroit Stoker Company.* This company took out patents on the Detroit V-type stoker, similar in design to the Murphy stoker, the clinker crusher being composed of rotating disks.

1904—*Wetzel Stoker Company.* The Wetzel stoker is a front-inclined overfeed stoker that operates on natural draft and has movable and stationary grate bars.

### Traveling- and Chain-Grate Stokers

From the dates given below it will be seen that traveling-grate stokers were introduced earlier than any other type.

1819—*Brunton* (English). Brunton developed a traveling grate which is said to have been the first mechanical stoker brought out in England; it was a circular grate traveling on a vertical spindle.

1834—*Bodmer* (English). In this stoker the grate traveled from the front to the back of the furnace; it was probably the first of its type to be built.

1841—*Jukes* (English). Jukes may be said to have been the original inventor of the traveling chain grate.

1871—*R. F. Weller* (American). Weller was the first to bring out a traveling-grate stoker in America. At least, this is the earliest record available.

1893—*E. B. Coxe.* Living in the anthracite regions and being impressed with the mountains of fine coal that were being dumped along the sides of the mines as a waste product, Mr. Coxe brought out a chain-grate stoker especially designed to burn the small sizes of anthracite, and probably was the first one to use forced draft under a chain-grate stoker. This stoker has been improved upon very considerably and is now manufactured by the Combustion Engineering Corporation. Mr. Coxe can be considered the father of the chain-grate stoker in this country, having made it a present-day success. His two 1893 patents covered not only the design, but also the process of the forced draft and the zoning of the air in multiple air boxes.

1898—*William M. Green and John R. Gent—Green Chain Grates.* The Green Engineering Co. put this stoker on the market originally to burn the Illinois and Middle-West coals, but it is today also burning lignite coals successfully in the Far West. The company has recently developed a forced-draft chain grate.

1898-1904—*The Playford Chain-Grate Stoker.* During this period the Playford chain-grate stoker was brought out by the Rosedale Foundry & Machine Company.

1904-1906—*Babcock & Wilcox Chain Grates.* Patents were taken out by the Babcock & Wilcox Co. on chain grates, and they have put on the market a chain-grate stoker for use with their own boiler only. Their latest development is a forced-draft chain-grate stoker.

1910—*Westinghouse Electric & Manufacturing Company.* About this time the Westinghouse Electric & Manufacturing Co. brought out their chain-grate stoker.

1910—*The Illinois Stoker Company.* This company first brought out the Illinois chain grate for natural draft, and later their forced-draft chain grate, Type G.

1911—*Frederick Girtanner.* Girtanner, of the Laclede-Christy Clay Products Co., filed applications for patents, which were subsequently granted, and this company is now manufacturing the Laclede-Christy chain grate.

1919—*Joseph Harrington — Traveling-Grate Stoker.* Harrington brought out his forced-draft stoker for burning anthracite, coke breeze, and Western coals, zoning his air in multiple air boxes.

1919—*Stowe Traveling-Grate Stoker.* L. R. Stowe brought out a new type of stoker, consisting of alternating traveling grates and stationary tuyeres inclined toward the bridge-wall at an angle of 20 deg. This stoker is manufactured and marketed by the Laclede-Christy Clay Products Company.

The author is indebted to Messrs. Joseph G. Worker and Thomas A. Peebles for particulars given regarding the early English patents.

## Facts About Coal Conservation*

Many people are under the impression that the cure for our fuel problems lies entirely in the more economical generation of power. The large central power stations are pointed to as being the great economic factors in decreasing coal consumption, and it is stated that if all the small power plants were closed down and their power supplied from the central stations, much of the coal now burned in the multitude of small plants would be saved. This point of view arises from the idea that the amount of coal used is dependent entirely upon the efficiency with which coal is used in the generation of power.

When business is going at a fair rate, this country consumes approximately 500,000,000 tons of coal a year, distributed about as follows:

| Name of Industry | Per Cent of Total Coal Consumed |
|---|---|
| Steam Railways | 28 |
| Industries other than steel and coke plants | 28 |
| Coke plants (not including gas plants) | 17 |
| Domestic consumers | 11 |
| Electric utilities | 8 |
| Steel plants | 7 |
| Coal-gas plants | 1 |

Of the 28 per cent used by industries other than steel and coke plants, a large part would be needed in any case for heat. To the extent that heat is needed, power can be generated as a byproduct with little increase in the amount of fuel used.

If one-half of the coal used by the group of industries making up 28 per cent of our consumption is for heat, there remains an item of only 14 per cent for central stations to work on. This is about equal in quantity to our consumption for domestic purposes, which is used entirely for heating. While no one can say what percentage of the fuel now used by the industries is needed for heating, it is certain that there are many factories where power is nothing but a byproduct of the heating operations. In such cases the efficiency of the power-generation apparatus is a matter of indifference, as long as it is not reduced to the point where the prime movers supply more exhaust steam than can be economically absorbed by the heating processes. So it may happen that a supposedly inefficient prime mover in a small industrial plant may produce power with a fuel consumption that is only an insignificant fraction of that required by the most efficient central station. This is on the basis of charging against power production only the additional fuel required above that which would be needed in any case to take care of the heating operations.

Not only do the best central stations throw away to the condensers approximately 80 per cent of all the energy supplied in the steam, but of the remaining 20 per cent only about four-fifths reaches the consumer, the other fifth being lost in transmission.

Considerable attention has been given to the important field of using exhaust steam for heating. Another matter of great importance is that of utilizing the waste heat from metallurgical furnaces. By the very nature of the processes, many of these furnaces must waste as much as 80 per cent of all the heat in the coal, but a large proportion of this can be recovered by waste-heat boilers.

The impression is general, particularly among business men who have had no engineering training, that it takes much more coal to produce a pound of high-pressure steam than lower-pressure steam. As a matter of fact, the difference is insignificant, amounting to perhaps 5 or 6 per cent. It is little short of an economic crime to blow steam into a multitude of heating systems at low pressure without first taking therefrom the mechanical work that this steam would be capable of performing if it were generated at a reasonable working pressure.

There are hundreds of large hotels, clubs, hospitals and other public buildings that are purchasing electricity. This is generated by burning coal in central-station plants. At the same time these institutions are operating low-pressure boiler plants for heating purposes. Many of these plants could easily generate all the electrical energy they need with practically no increase in their coal consumption.

*Abstract of paper by Egbert Douglas, consulting engineer, published in the November, 1922, issue of *Industrial Management.*

## Stoker Manufacturers' Association

The fall meeting of the Stoker Manufacturers' Association was held at Hot Springs, Va., on Tuesday, Wednesday and Thursday, Nov. 21, 22 and 23.

In his opening address President S. A. Armstrong remarked the improvement in the business outlook and in the stoker business in particular, spoke of the several consolidations of stoker-manufacturing interests that have occurred, remarked upon the competition coming from gas, oil and powdered fuel and made the far-seeing suggestion that the Association may ultimately broaden out to include all methods of handling all fuels and deal with service in combustion rather than the manufacture and sale of one class of combustion apparatus. He gave recent labor statistics and pointed out the effect of restrictive immigration laws upon the available labor supply.

Following the report of the Cost Accounting Committee by W. V. Sauter, chairman, the Association listened to an address upon "Cost Accounting in Industry" by Arthur Lazarus, of the Fabricated Production Department of the Chamber of Commerce of the United States.

In the evening the report of the Foundry Committee was presented by William Lloyd, chairman; and S. L. Nicholson, assistant to the president of the Westinghouse Electric & Manufacturing Co., gave an address, with colored diagrams, illustrative of industrial and labor conditions, costs of living, etc., and pointed out several of the broader activities that should engage the attention of trade associations.

On Wednesday morning David F. Jordon, assistant professor of finance, New York University, addressed the Association upon "Looking Ahead in Business," and the report of the Commercial Committee was considered. As Frank Bigelow has retired from the stoker business, his place as chairman of this committee was filled by the appointment of M. Alpern, who conducted the discussion. Mr. Bigelow was made an honorary member.

The Commercial Committee's report, the discussion of which extended into Thursday forenoon, included such subjects as: "Securing Changes in the Present Immigration Law"; "Publicity with Respect to Service and Repairs"; "Statistics Relative to Horsepower of Stokers Installed"; "Specifications for Refractories"; "Ash-Hopper Specifications"; "Specifications for Stoker Auxiliary Equipment"; "What Should Be Done To Foster a Spirit of Interest Within the Association?" "Seeking Expressions from the Outside as to the Evils That Exist, and the Methods Used in the Stoker Industry."

The report of the Engineering Committee, presented by the chairman, John Van Brunt, after the completion of the discussion of the Commercial Committee's report on Thursday morning, dealt with seven items:

1. Sizing of Coal for Stokers: Run-of-mine coal, when intended for stokers should be crushed to pass through a 1¼-inch ring. Crushing below this size materially reduces the capacity of the crushers and will perhaps produce an excessive amount of fines.

2. Determination of Moisture in Coal in Boiler tests: Where the coal used in tests contains an appreciable amount of surface moisture or is apparently wet, the preliminary moisture determination should be made in the field. Of the various methods suggested, that of making use of a number of cotton bags, each to be filled with six or eight pounds of coal, immediately weighed and dried above the boiler, was considered the most practical and was recommended by the committee.

3. Methods of Measuring Exit Gas Temperatures: It was felt that this matter could be properly left in abeyance, at least until the revision of the Boiler Test Code of the A.S.M.E. is completed.

4. Standardized or Recommended Designs of Coal Spreaders and Ashpits with Particular Reference to the Minimum Capacity of Ashpits: The committee recommended this subject to the meeting for discussion. If the Association preferred not to attempt to formulate any standard practice, the subject would be a proper one for treatment in the Handbook, the publication of which the Association has in mind.

5. Effect of Added Moisture to Coal Before Delivering to Stokers: This is a matter upon which the Association cannot well standardize, and was thought also to be a proper subject for the Handbook.

6. The Question of Stack Sizes and Heights: Is it possible for the boiler and stoker manufacturers to agree on some one satisfactory method of determining correct sizes? Referred to Joint Committee of the Boiler and Stoker Manufacturers' Associations.

7. Draft over Fire: Inasmuch as the effect of pressure at the top of a high furnace is something that directly affects the boiler manufacturer, and only indirectly the stoker manufacturer, it was decided that this matter also should be referred to the Joint Committee of the Boiler and Stoker Manufacturers.

F. H. Daniels, chairman of the Fan Committee, discussed the contact of the Association with that of the fan manufacturers. Particular stress was put upon the fact that fans run in parallel should have the same characteristics.

Lloyd R. Stowe, chairman of the Conference Committee with the A.S.M.E., presented portions of the tentative report of the Committee on Instruments and Apparatus of the Power Test Codes Committee, and A. H. Blackman, chairman of the joint committee with the A.B.M.A., told of progress being made with boiler and stoker reports.

The entertainment features consisted of a Kicker's Handicap, and the S.M.A. championship golf tournaments and a banquet on Wednesday evening, at which the golf prizes were distributed.

## British Board Makes Interesting Statement on Water Power

The water-power committee of the Conjoint Board of Scientific Societies of Great Britain reports, according to advices received by the Department of Commerce, that the potential water power of the British Empire, including all dominions, colonies and possessions, is 50,000,000 to 70,000,000 hp., all of which is capable of immediate economic development. This enormous supply will undoubtedly be developed under the guidance of competent authority and not left to chance.

The conjoint board gives the following estimate of the power available and now being used in the various countries:

| Countries | Brake Horsepower Available | Brake Horsepower Developed | Per Cent Utilized |
|---|---|---|---|
| United States | 28,100,000 | 7,500,000 | 26.7 |
| Canada | 22,900,000 | 3,385,000 | 14.8 |
| Austria-Hungary | 6,460,000 | 570,000 | 8.8 |
| France | 5,587,000 | 1,500,000 | 26.9 |
| Norway | 6,500,000 | 1,250,000 | 19.2 |
| Spain | 5,000,000 | 540,000 | 10.8 |
| Sweden | 5,500,000 | 1,100,000 | 20.0 |
| Italy | 4,000,000 | 1,250,000 | 31.3 |
| Switzerland | 3,000,000 | 650,000 | 21.7 |
| Germany | 1,425,000 | 750,000 | 52.5 |
| Great Britain | 900,000 | 200,000 | 22.2 |

It is estimated that 75,000,000 hp. is being used for the world's factories, including electric lighting and street railways, 21,000,000 hp. for the world's railways, and 24,000,000 hp. for the world's shipping.

---

In sampling delivered coal, the Bureau of Mines follows a definite procedure. A sample weighing not less than 1,000 pounds is systematically collected by taking equal increments at regular intervals throughout the delivery, while coal is being loaded or unloaded, and crushing and reducing this sample by successive stages to laboratory size. In using analyses of samples of delivered coal, the reader must recognize that the coal is not always of uniform size and that the impurities are not uniformly distributed throughout the mass. Some variation in the results obtained are consequently to be expected; if the same mass of coal were sampled a number of times, the analyses would not agree absolutely except by chance. It is only when a number of such analyses are available, representing a considerable tonnage mined over a period of time, that the average value and range of variation of a particular coal become known with assurance. With reasonable tolerances, however, for these variations, delivered coal can be sampled accurately enough for all practical purposes.

# News in the Field of Power

## Sign Colorado River Treaty

### Seven States Agree—Control of Power Development Passes to Federal Power Commission

DETAILS of the compact made between the seven states interested in the development of the Colorado River and the Federal Government, at the recent meeting of the Colorado River Commission, have just been announced by the Department of Commerce.

The treaty, signed at Santa Fé, N. M., on Nov. 24 by Secretary Hoover and the commissioners, divides the seven states into two groups, with California, Nevada and Arizona in the lower division, and Utah, Wyoming, Colorado and New Mexico in the upper division. Both divisions are entitled to the exclusive use of 7,700,000 acre-feet of water per year, and the lower division is granted the right to increase this amount by 1,000,000 acre-feet a year if necessary. Any water going to Mexico shall be supplied from the surplus over that alotted to the upper and lower divisions. If this surplus is inadequate, then each division shall supply an equal portion of its waters to make up this deficiency. Any waters remaining after the above requirements have been met shall be apportioned according to the recommendations of the seven states and of the President.

Subject to the approval of Congress, navigation on the Colorado River has been declared secondary to the uses of such waters for domestic, agricultural and power purposes. Similarly, power generation has been declared secondary to agricultural and domestic consumption. However, this does not take from any state the right to regulate the use of waters entirely within its boundaries. The compact shall become obligatory when approved by the legislatures of each of the States and by Congress.

Secretary Hoover stated that the matter of power development had been taken entirely out of the hands of the Commission by direction of the President and delegated to the Federal Power Commission. The flood protection needs of the Imperial Valley were recognized as an extremely urgent reason for immediate erection of control works, which will probably be undertaken at Boulder Canyon by the Federal Government.

## Two Children Killed in Boiler Explosion

The entire family of L. S. Curtis, an employee of the Goss sawmills, near Aragon, about eighteen miles from Rome, Ga., were the victims of a boiler explosion in the sawmill on Nov. 23, according to the *Atlanta Constitution*. Two of the children were scalded to death and another child and the father and mother were severely burned and may die.

The father is the fireman at the mill. The wife, as was her habit, had brought him dinner from their home nearby. The family was eating together, the parents forming the center of a half circle about the firebox, just in front of the boiler, where they were sitting to keep warm. The blowing up of the boiler covered the entire party with steam, the children, who were seated directly in front of where the break occurred, receiving the full discharge.

## Revokes Water-Power Permits

### Federal Power Commission Adopts New Policies on Permits and Valuation

FOLLOWING a policy settled upon several weeks ago, the Federal Power Commission, at its meeting on Nov. 20, revoked preliminary permits in two cases where the required preliminary engineering investigations had not been carried out within a reasonable time. A permit issued Oct. 12, 1921, to A. Reed Bingham, of Pensacola, Fla., looking toward developments on the Perdido, Blackwater and Styx rivers in Florida and Alabama, was revoked on the ground that stream gaging had not been done as required. A preliminary permit issued March 14, 1922, to J. F. Myser and E. E. Drach, of Denver, Colo., was revoked because the required engineering investigations had not been made.

Another new policy was marked by the Commission's action in waiving the question of valuation and approving a license for the Western States Gas & Electric Co., of San Francisco, for a constructed project on the Trinity river in Northern California, in a national forest. Heretofore the Commission has insisted that valuation be made before a license was granted. In this case, the question was left for the future and the Commission agreed to accept the valuation fixed by the State Railroad Commission.

## Condemns Private Utility System

The City of Los Angeles has instituted condemnation proceedings against the generating plant and distribution system of the Los Angeles Gas & Electric Corporation, as a result of the failure of the city and the company to agree upon a basis of sale. The company's system consists of a generating plant of approximately 70,000 hp., five substations and a distribution system supplying between 25 and 30 per cent of the electricity used in Los Angeles. It is said to be worth between six and seven million dollars.

## Heating Oil for Marine Use

### Navy Seeks Practical Means for Using Heavy Oils Under All Conditions —Tries Re-circulation

EXPERIMENTS of prime importance to all users of fuel-oil, and especially to marine interests, where the problem is most acute, are being conducted by the Navy Department to develop a quick and safe method of heating oil in the storage tanks so that a heavy oil may be used under all conditions.

The successful solution of this problem would mean that a heavy fuel oil could be used in any climate; that the steaming radius would be increased, as the heavier the oil the greater its thermal value, and the fuel cost would be reduced because heavy oil is ordinarily forty to sixty cents a barrel cheaper than the lighter and more refined oils. It would also permit tanks to be refilled at any port where there is an oil station, regardless of the quality of oil sold.

The existing systems of heating oil, while used with entire success by merchant vessels in certain lines of trade, are none of them adapted to all conditions. Difficulty in pumping the heavy oils, and in cleaning the relatively small and inaccessible tanks used by the Navy, forms a part of the problem.

The Navy experiments have been along the line of re-circulation. The general idea is to use a preliminary heater, arranged so that two-thirds of its contents are returned to the tank, thus heating the stored oil; the remaining third passes on to the fire heater. Experiments at the fuel-oil testing plant at the Philadelphia Navy Yard have shown that the pumps may be running full capacity on heavy marine oil, grade C, in from three to five minutes after starting the re-circulation system. Light oil is used for starting up. The system has been ordered installed on the battleship Maryland for further experiments.

## Steamship "Mauretania" Has Turbine Trouble

Near the conclusion of a satisfactory voyage, a noise developed in the starboard low-pressure turbine of the steamship "Mauretania" on Saturday, Nov. 25, making it advisable to shut down this turbine and lash the shaft for the remaining run from the Ambrose Channel Lightship to the Cunard pier in New York City.

The "Mauretania" is equipped with four shafts. The two outside shafts are connected to high-pressure turbines while each inner shaft is driven by a low-pressure turbine for going ahead and a reversing turbine for maneuvering in making and leaving the dock. The turbines, of the Parsons reaction

type, are so arranged that when one low-pressure unit is out of commission the high-pressure unit on the same side, which ordinarily exhausts into it, can be connected directly to the condenser. In maneuvering, the high-pressure turbines are not used, but valves admit live steam directly into the low-pressure ahead turbines or the reversing turbines.

On account of the starboard low-pressure turbine being lashed it was not possible to use this shaft, and consequently the reversing turbine connected to it was out of commission when the pier was reached. With a strong ebb tide and heavy wind, some difficulty was experienced in docking the ship, despite the assistance of fourteen tugs. It was decided to postpone examination of the turbine giving trouble until the ship's return to Southampton, whither she is now proceeding, driven by three shafts. The cause of the internal noise is still undetermined.

## Another Industrial Plant To Burn Powdered Coal

The conversion of its hand-fired boiler plant to pulverized coal has been decided upon by the Clark Thread Co., Newark, N. J.

A separate pulverizing plant will be built, with a capacity of ten to twelve tons an hour. The coal will be dried in a Fuller indirect-fired dryer, using pulverized coal as fuel, and then will be pulverized in two Fuller screen type, gear-driven mills. The powdered coal will be conveyed from the mills to the boiler bins, a distance of about 600 ft., through a Fuller-Kinyon conveying system. A 5-in. line will be used, distribution to the individual service bins being through ten two-way switching valves, connecting the main line with branch lines. This conveying system will be equipped with electro-pneumatic control, by which the coal can be diverted from the main line through any of the switching valves by the operator in the coal house. Also, the condition of the coal supply in each bin will be indicated by lights, automatically operated on the switchboard in the coal house, so that the mill man will have constant knowledge of the fuel conditions throughout the plant.

Each of the ten 5,000-sq.ft. Stirling boilers will be equipped with three Fuller-Lehigh pulverized coal feeders and three Fuller-Lehigh vertical flare type burners. The boilers will operate at 125 to 150 per cent rating. The Fuller Engineering Co. has been awarded the contract for the design and construction of the powdered coal preparation plant and the conversion of the hand-fired boilers to pulverized coal firing.

## Obituary

**Frank Engelhard**, founder of the Hercules Float Works, Springfield, Mass., died on Nov. 6. Born in Germany in 1843, Mr. Engelhard was educated in that country, coming to New York City in 1862. Shortly after his arrival he joined the army, and served through to the end of the Civil War with the First Connecticut Light Battery. Mr. Engelhard was an inventor as well as an industrialist. His inventions include pulp discharge valves for paper mills, rolling machines for irregular shapes, air compressors, and a process of electro-deposition of metals, resulting in the introduction of seamless copper floats and air chambers capable of withstanding high pressures. He also developed automatic fire fighting appliances, safety gas lighting apparatus and sheet metal spinning devices. Of a retiring disposition, he belonged to no fraternal or engineering societies, though he took an active part in politics, being affiliated with the Republican party.

## Coming Conventions

**American Society of Mechanical Engineers**, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 4-7.

**American Society of Refrigerating Engineers**; W. H. Ross, secretary, 154 Nassau St., New York City. Annual meeting at New New York City, Dec. 5-7.

**National Exposition of Power and Mechanical Engineering**, Grand Central Palace, New York City, Dec. 7-13.

**Kansas Engineering Society**; T. M. Averill, secretary, Topeka, Kan. Annual meeting at Topeka, Dec. 14-15.

**American Association for the Advancement of Science**; L. O. Howard, secretary, Smithsonian Institution, Washington, D. C. Annual meeting at Boston, Dec. 26-30.

**American Engineering Council**; L. W. Wallace, secretary, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 11-12.

**Marine Engineers' Beneficial Association**; George A. Grubb, secretary, Machinists' Bldg., 9th St. and Mount Vernon Place, Washington, D. C. Annual meeting at Washington, Jan. 15-20.

**Iowa Engineering Society**; Lloyd A. Canfield, secretary, 406 Flynn Bldg., Des Moines. Annual meeting at Des Moines, Jan. 23-26.

**American Society of Heating and Ventilating Engineers**, 29 West 39th St., New York City. Annual meeting: Jan. 23 at New York City, Jan. 24-26 at Washington, D. C.

**American Institute of Electrical Engineers**, 29 West 39th St., New York City. Mid-winter convention at New York City, Feb. 14-16.

**American Institute of Mining and Metallurgical Engineers**, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 19-21.

## Personals

**Calvin W. Rice**, secretary of the **A.S.M.E.**, was tendered an informal dinner by a number of friends at the Engineers' Club, New York City, on Nov. 28. Mr. Rice, who had just returned from South America, where he represented Uncle Sam's engineering societies at the Engineering Congress, gave an interesting account of his visit to the Brazilian exposition and of his subsequent travels over the southern continent. Prof. G. F. Kuntz started the evening in a fitting manner by unfurling a Brazilian flag. The A.S.C.E. was represented by Fred Lavis, and W. L. Saunders, of the Ingersoll-Rand Co., was toastmaster.

## Trade Catalogs

**Plug Valves**—Homestead Valve Mfg. Co., Homestead, Pa. Catalogue No. 40, giving price lists and dimensions of the complete line of Homestead valves, including the new lubricated quarter-turn valve.

**Spray Pond Equipment**—Binks Spray Equipment Co., 3114-26 Carrol Ave., Chicago. Catalog No. 4-D, showing the construction of the "Spra-Rite" nozzle and giving data on a large number of installations. A table of operating characteristics is included.

**Oil Engines**—Anderson Foundry & Machine Co., Anderson, Ind. Catalog No. 12, describing and illustrating the construction, manufacture and characteristics of type K and type H Anderson oil engine—vertical, two-cycle, dry mixture, medium compression, solid injection type.

**Mechanical Oil Burners** — Peabody Engineering Corp., 110 East 42 St., New York City. Bulletin No. 103, explaining the Peabody wide range, centralized control system of burning liquid fuels. The Peabody-Fisher mechanical oil burner is described and illustrated, although no correct sectional view of the burner tip is given.

## Fuel Prices

### BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

| Coal | Market Quoting | Nov. 20, 1922 | Nov. 27, 1922 |
|---|---|---|---|
| Pool 1, | New York | $4.50–5.50 | 5.00–5.25 |
| Smokeless, | Columbus | 6.00–6.25 | 6.00–6.35 |
| Clearfield, | Boston | 3.50–4.25 | 3.25–4.00 |
| Somerset, | Boston | 3.75–4.50 | 3.50–4.25 |
| Kanawha, | Columbus | 3.50–3.75 | 3.25–3.50 |
| Hocking, | Columbus | 3.25–3.75 | 3.00–3.50 |
| Pittsburgh No. 8 | Cleveland | 3.50–3.75 | 3.40–4.00 |
| Franklin, Ill., | Chicago | 4.00–4.25 | 4.00–4.25 |
| Central, Ill., | Chicago | 3.00–3.25 | 3.00–3.25 |
| Ind. 4th Vein, | Chicago | 3.75–4.00 | 3.75–4.00 |
| West Ky., | Louisville | 2.25–2.75 | 2.00–2.50 |
| Big Seam, | Birmingham | 2.25–2.50 | 2.25–2.50 |
| S. E. Ky., | Louisville | 3.75–4.25 | 3.50–4.00 |

### FUEL OIL

**New York**—Nov. 29, Port Arthur light oil, 22@25 deg. Baumé, 4¼c. per gal.; 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

**Chicago**—Nov. 18, for 24@26 deg. Baumé, 90c. per bbl.; 32@36 deg., 2⅞@3c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

**Philadelphia** — Nov. 27, 26@28 deg. Baumé, Oklahoma, 95c.@$1.05 per bbl.; 30@34 deg., Oklahoma (group 3). 2¾@3c. per gal.; 16@20 deg. Seaboard, $1.35@$1.40 per bbl.

**St. Louis**—Nov. 20, f.o.b. Oklahoma 24@26 deg. 95c. per bbl.; 26@28 deg. $1 per bbl.; 28@30 deg., $1.05 per bbl.; Gas oil 32@36 deg. 2⅞@3c. per gal.; 36@40 deg. distillate, 3½@3¾c. per gal.

# New Plant Construction

**PROPOSED WORK**

**Ala., Albany**—The Secretary of the Bd. Educ., will receive bids until Dec. 19 for the construction of a 2 story, 90 x 300 ft. high school. W. B. Ittner, 9th and Locust Sts., St. Louis, Mo., Archt. Separate bids will be received for heating system.

**Ariz., Tucson**—Lyman & Place, Archts., 79 North Stone Ave., will receive bids about Dec. 15th for the construction of a 3 story, 200 x 285 ft. high school. Estimated cost $750,000.

**Ark., Cotter**—The Dixie Power Co., Batesville, will receive bids until Jan. 1, 1923, for the construction of hydro-electric plants with dams on White, Buffalo and Big North Fork Rivers, here. Estimated cost $15,000,000.

**Calif., Emeryville** — The Westinghouse Elec. & Mfg. Co., 1st Nat'l. Bank Bldg., San Francisco, is having plans prepared for the construction of a manufacturing plant here. Estimated cost $1,000,000. Private plans. Equipment detail not reported.

**Calif., Hayward**—E. L. Macabee, Mgr., Hunt Bros. Packing Co., Lower B St., and Chn. of Cold Storage Plant, Com. of Chamber of Commerce, backs movement to finance construction of cold storage plant. Estimated cost $100,000. Plant will be constructed either by the formation of a local company or by a corporation already established here.

**Calif., Isleton**—The J. F. Butts Co., 2 Pine St., San Francisco, subsidiary of the Warmington-Duff Co., 2 Pine St., is receiving bids for the construction of a group of buildings, including a 1 story, 100 x 260 ft. main building, 80 x 120 warehouse, 30 x 70 ft. can house, boiler room building, 36 x 200 ft. wharf, 30 cottages for employees and an apartment house for 200 families. W. J. Miller, 417 Market St., San Francisco, Archt.

**Calif., Oakland**—Roos Bros., c/o Weeks & Day, Archts., California Ins. Bldg., San Francisco, is having plans prepared for the construction of a 10 story, 90 x 230 ft. theater and apartment building on Grand Ave. here. Estimated cost $500,000. Equipment detail not reported.

**Calif., Redwood City** — The Sequoia Union High School Dist., received bids for the construction of a high school on Broadway and State Highway, as follows: general contract from R. Trost, 26th and Howard Sts., San Francisco, $210,704, Beck & Kohn, 180 Jessie St., San Francisco, $223,241, Hannah Bros., 142 Sansome St., San Francisco, $229,000; heating and ventilating, J. F. McGowan, 3786 Mission St., San Francisco, $33,997, W. H. Picard, 5656 College Ave., Berkeley, $34,372, J. E. O'Mara, 443 Minna St., San Francisco, $35,990. Noted June 27.

**Calif., San Francisco**—The state, G. B. McDougall, Archt., Forum Bldg., Sacramento, is having plans prepared for the construction of a group of college buildings on Haight and Buchanan Sts. Estimated cost $500,000. B. J. Maybeck, Lick Bldg., Assoc. Archt. Equipment detail not reported.

**Calif., Santa Barbara**—The High School Dist., E. C. Dengate, Clk., will receive bids until Dec. 18 for the construction of a 1 and 2 story high school. Estimated cost $500,000. W. H. Weeks, 369 Pine St., San Francisco, and R. F. Sauter and E. K. Lockard, San Marcos Bldg., Archts. Equipment detail not reported. Noted Aug. 1.

**Calif., Ukiah**—J. F. Williams, Box 285, Fortuna, has had plans prepared for the construction of a power plant equipped with turbine water wheels, utilizing a fall of 430 ft. developing 22,580 hp. 500 sec.-ft. through penstocks; water to be taken from North Fork of Eel River; also a canal 25,185 lin.ft., 25 ft. wide on top, 5 ft. on bottom, 10 ft. deep; storage dam 300 ft. high 665 ft. long, 138 ft. long on bottom, 15 ft. wide, storing 137,385 acre-ft. of water. Estimated cost $2,000,000.

**Calif., Visalia**—The Bd. Supervisors, Tulare County, G. R. Prestidge, Clk., plans the construction of a courthouse and have taken option on 5 city blocks as site for same. Cost will exceed $500,000.

**Conn., New Haven**—The Connecticut Co., 127 Church St., is having plans prepared for remodeling power plant and the construction of an addition, including new equipment, etc. Estimated cost $150,000. Architect not announced.

**Fla., Jacksonville**—The Bd. Pub. Instruction of Duval County will receive bids until Dec. 9 for the construction of a 3 story, 159 x 224 ft. Junior High school. Freeley & Benjamin, Bisbee Bldg., Archts. W. B. Ittner, 911 Locust St., St. Louis, Mo., Engr. Separate bids will be received for steam heating, etc.

**Ga., Atlanta**—The Bd. Educ., c/o J. N. Landers, City Purch. Agt., will receive bids until Dec. 8 for the construction of a 3 story Junior High school on Peeples and Beecher Sts. Pringle & Smith, 821 Atlanta Trust Co. Bldg., Archts. Spiker & Lose, Forsyth Bldg., Engrs. Separate bids will be received for heating, ventilating, etc.

**Idaho, Warren**—The Unity Gold Mines, is receiving bids for the construction of a hydro electric plant, capacity 1,000 hp., also 10 mi. of transmission line, etc. Estimated cost $75,000. Alexander Potter, 50 Church St., New York, Engr.

**Ill., Lena**—The city, J. N. Gates, Clk., plans improvements to water supply system, including more economical pumping equipment. Estimated cost $15,000. W. G. Kerchoffer, Dean Bldg., Madison, Engr.

**Ill., Oak Park**—Weller & Rippel, Archts., 140 South Dearborn St., Chicago, is having plans prepared for the construction of a 5 story apartment hotel on Oak Park and Madison Sts., here. Estimated cost $800,000. Owner's name withheld. Equipment detail not reported.

**Ill., Sycamore**—E. J. Morgan is in the market for a 72 x 18 H R T boiler to pass Hartford 125 lb. inspection.

**Ind., Anderson**—The Union Traction Co. is in the market for power generating equipment for new central power plant.

**Ind., Indianapolis**—N. Todd, 415 Lemcke Bldg., is in the market for ice manufacturing and cold storage machinery and equipment.

**Kan., Kansas City**—The Pershing Road Properties Co., 412 Scarrett Bldg., Kansas City, Mo., is having plans prepared for a 115 x 138 ft. public market building on 24th St. and Pershing Rd. Estimated cost $1,000,000. W. S. Ferguson & Co., 1900 Euclid Ave., Cleveland, O., Engrs. Equipment detail not reported.

**Ky., Paducah** — The Paducah Ice Co. plans the construction of 2 additional units to its ice manufacturing plant. Estimated cost $70,000. Architect not announced. Owner is in the market for refrigeration machinery and equipment.

**La., Lecompte**—The city voted $40,000 bonds for electric light and waterworks extensions. Swanson-McGraw, Inc., United Fruit Bldg., New Orleans, Consult. Engrs.

**Mass., Springfield**—The School Bd. is having plans prepared for the construction of a 3 story high school on Elliot St. Estimated cost $800,000. E. C. & G. C. Gardner, 33 Lyman St., Archts. Equipment detail not reported.

**Mich., Detroit**—H. Silverman, 1030 Penobscot Bldg., is having plans prepared for an 11 story, 100 x 120 ft. apartment building, including vacuum steam heating plant with 3 high pressure boilers, refrigerating plant, incinerators, etc., on Cass and Putnam Aves. M. H. Finkel, 333 Majestic Bldg., Archt.

**Mich., Kalamazoo**—The city, H. Bland, Purch. Agt., City Hall, is receiving bids for sump pump 1 in. vertical 25 gal. per min. 10 ft. head centrifugal pump 36 in. cover plate for pit 5 ft. deep, direct connected 3 phase, 60 cycle, 440 volt, floor switch with auxiliary to automatically start and stop. Billingham & Cobb, Engrs. Contract has been awarded for the pumping plant.

**Mich., Lansing**—The United Produce Co., c/o W. S. Holmes, Archt., Tussing Bldg., has sketches prepared for a 4 story, 84 x 280 ft. cold storage building on Kalamazoo St. Estimated cost $200,000.

**Mich., Mottville**—The Michigan Gas & Elec. Co., Three Rivers, plans the construction of a hydro-electric plant to include a 2,500 hp. 2,000 kw. power house, on the St. Joseph River. Estimated cost $400,000. Private plans.

**Mich., St. Joseph**—J. T. Townsend is in the market for refrigerating machinery and motor.

**Mich., St. Joseph**—The Whitcomb Hotel is having plans prepared for the construction of an outside power plant, also brick stack. Equipment will include boilers and generating unit. Cahill & Douglas, 217 West Water St., Milwaukee, Wis., Engrs.

**Minn., Minneapolis**—The Bd. Educ., 305 City Hall, F. S. Gram, City Purch. Agt., will receive bids until Dec. 4 for refrigerating machinery, also woodworking and sheet metal working machinery for the Lincoln and Bryant Junior High Schools.

**Minn., Westbrook**—The village will receive bids until Dec. 11 for waterworks improvements, including 11,375 ft. 4 in. c.i. pipe, 14 hydrants, 11 gate valves, 4,200 lbs. special castings, drill well (6 to 14 in. dia. about 650 ft. deep) pump house and pumping unit. Estimated cost $15,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Ia., Engr. Noted Nov. 14.

**Mo., Kansas City**—The Bd. Educ. is having plans prepared for a 4 story, 300 x 325 ft. high school. Estimated cost $1,400,000. C. A. Smith, 600 Finance Bldg., Archt. Plans will be completed about Mar., 1923. Equipment detail not reported. Noted Nov. 7.

**Mo., LaPlata**—The city plans an election the latter part of December, to vote $190,000 bonds for waterworks system, including filtering station, also sewers and sewerage disposal works and pumping station.

**Mo., St. Louis**—The Guild Investment Co., c/o Weisels-Gerhart R. E., 8th and Chestnut Sts., plans to build 6 story, 115 x 215 ft. apartment building on West Pine and Euclid Sts. Estimated cost $500,000.

**Mo., Sedalia**—The Bd. Educ., plans election, Dec. 8, to vote $500,000 bonds for the construction of a 3 story high school. Estimated cost $500,000. Architect not announced.

**N. J., Princeton**—The Princeton Inn Co., c/o A. J. Thomas, Archt. and Engr., 15 East 47th St., New York, is having preliminary plans prepared for the construction of a hotel here. Estimated cost $350,000. Equipment detail not reported. Noted Aug. 15.

**N. Y., Alden**—Erie County Bd. Supervisors, City Hall, Buffalo, is having preliminary sketches prepared for the construction of a 75 x 100 ft. power house and refrigerating plant in connection with proposed County Home, here. W. A. Kidd, 524 Franklin St., Buffalo, Archt. Noted Nov. 7.

**N. Y., Brooklyn**—The Bd. Educ., 500 Park Ave., New York, will soon receive bids for the construction of a 5 story, 60 x 100 ft. addition to P. S. 121, including steam heating system, on East 102nd St. and 2nd Ave., Estimated cost $500,000. C. B. J. Snyder, Concord St. and Flatbush Ave. Ext., Archt. and Engr.

**N. Y., Buffalo**—The Buffalo Steel Car Co., East Walden Ave., has had plans prepared for a 35 x 100 ft. power plant. Estimated cost $25,000. Plumer & Mann, 700 Main St., Archts.

**N. Y., Jamaica**—The Mary Immaculate Hospital is having plans prepared for the construction of a 6 story hospital on Shelton Ave. Estimated cost $1,000,000. W. J. Boegel, 162 East 37th St., New York, Archt. and Engr. Equipment detail not reported.

**N. Y., Jamestown**—The New Ice & Coal Co., 925 Clinton St., plans the construction of an ice manufacturing plant. Estimated cost $18,000. Architect not announced. Owner is in the market for refrigeration machinery.

**N. Y., New York**—The Guaranty Trust Co., 140 Bway., plans the construction of a 23 story, 95 x 135 ft. office building on Bway. and Liberty St. Estimated cost $2,000,000. Cross & Cross, 681 5th Ave., Archts. and Engrs.

**N. Y., New York**—The G. R. Hall Syndicate, c/o Sugarman & Hess, Archts. and Engrs., 16 East 43rd St., will soon receive bids for the construction of an 80 x 115 ft. hospital on 72nd St. and West End Ave. Estimated cost $3,000,000. Equipment detail not reported.

**N. Y., New York**—Harper & Bros., 333 Pearl St., will soon receive bids for the construction of a 5 story publishing building on East 33rd St. Estimated cost $800,000. Warren & Webmore, 16 East 47th St., Archts. and Engrs. Equipment detail not reported.

**N. Y., New York**—The Physicians Medical Hotel Corp., c/o H. G. Wiseman, Archt. and Engr., 25 West 43rd St., is having plans prepared for the construction of a 9 story, 100 x 175 ft. hospital on 103rd St. and 5th Ave. Estimated cost $1,500,000. Equipment detail not reported.

**N. C. Lillington**—The Cape Fear Gravel Pits, Inc., C. W. Lacy, Pres., plans the construction of a large gravel production plant also a plant for the manufacture of building blocks and tile. Estimated cost $250,000. Water for washing the gravel, will be pumped from the Cape Fear River near here.

**Ohio, Akron**—The B. F. Keith Theatre Co., c/o E. F. Albee & Palace Theatre Bldg., New York, is having plans prepared for the construction of a 1 story theatre on Main St., here. Estimated cost $500,000. C. W. and G. Rapp, State Lakes Theatre Bldg., Chicago, Ill., Archts. Equipment detail not reported.

**Ohio, Ashland**—The J. E. Mathews Produce Co., is in the market for cold storage machinery and equipment, in connection with proposed 3 story 60 x 75 ft. cold storage plant. Noted Nov. 28.

**Ohio, Cleveland** — The Ambassador Improvements Co., c/o M. Mormorstein, 607 Ulmer Bldg., plans the construction of a 6 story, 118 x 200 ft. apartment building, including steam heating system, on East 89th St. and Euclid Ave. Estimated cost $500,000. S. H. White, 1032 Schofield Bldg., Archt.

**Ohio, Cleveland**—The Bd. Educ., F. G. Hogen, Dir., plans the construction of a 3 story, 40 room, Junior Commercial school, including steam heating system, on West 41st St. and Randall Rd., also a 2 story, 22 room elementary school on East 151st St. and Groveland Ave., estimated cost $900,000 and $500,000 respectively. W. R. McCornack, East 6th St., and Rockwell Ave., Archt. Bond issues recently approved.

**Ohio, Cleveland**—The Louis Abrams Co., L. Abrams, Pres., 525 Engineers Bldg., plans the construction of a 7 story apartment building, including steam heating system, on Euclid Ave. Estimated cost $500,000. D. A. Reamer, 17920 Detroit Ave., Lakewood, Archt.

**Ohio**—Dayton Lodge—F. & A. M., S. R. Jones, Chn. Bldg. Com., Masonic Temple, plans the construction of a Masonic Temple. Estimated cost $1,500,000. Architect not selected.

**Ohio, Dayton** — The United Brethren Church, Dayton Branches, will soon award the contract for the construction of a 14 story, 60 x 128 ft. office building, also a 7 story addition to adjoining structure, on 4th and Main Sts. Estimated cost $850,000. F. J. Hughes Co., 406 U. S. Bldg., Archts. Equipment detail not reported.

**Ore., Albany**—A. H. White has filed application for water power and storage reservoir site, capacity 25,000 cu.ft. 1,023 hp. on the South Santiam River near Foster, for the purpose of constructing and operating sawmills, and a railroad. Construction work to start in the spring.

**Ore., Medford**—W. E. Stevens is in the market for machinery and equipment for proposed cold storage plant.

**Ore., Portland**—W. Balzhiser, 633 Ainsworth Ave., is in the market for 500 kw. dynamo, switchboard, 600 hp. turbine water wheel for about 40 ft. head, and about 4 mi. feeder wire.

**Ore., Portland**—The Water Works Dept., L. S. Kaiser, Supt., City Hall, plans the construction of a North and South Portland pumping systems estimated cost $20,000; Sandy River control system, $3,000; Vernon stand pipe and house, $35,000; Myrtle Park system, $8,000; Fulton & Burlington system, $3,000; also repairs to present system, $209,350.

**Pa., Ambridge**—The Duquesne Light Co., 435 6th Ave., Pittsburgh, plans improvements to lighting and power equipment, including replacing wires with heavier types, new poles, etc., here. Estimated cost $25,000.

**Pa., Bedford**—L. F. Hoffman, is having plans prepared for a 3 story, 75 x 430 ft. hotel on Grandview St. Estimated cost $300,000. C. N. Friz, Lexington Bldg., Baltimore, Md., Archt.

**Pa., Johnston**—The Edw. Hahn Packing Co., Hickory St., is receiving bids for the construction of a 3 story, 48 x 108 ft. and 24 x 112 ft. packing plant addition. Estimated cost $65,000. Private plans. Owner is in the market for trolley conveying system and ice machines.

**Pa., Phila.**—The city, T. F. Armstrong, Purch. Agt., 316 City Hall, is in the market for a 50 ton refrigerating plant for the City Hospital.

**Pa., Phila.**—The Philadelphia College of Pharmacy plans the construction of three 3 and 4 story buildings, consisting of Educational, Administration and Research buildings on 43rd St. and Woodland Ave. Estimated cost $1,000,000.

**Pa., Scranton**—The Bd. of Pub. Works, W. LaFontaine, Dir., is receiving bids for an 85 hp. 125 lb. working pressure, fire box return flue boiler.

**Pa. Watsontown**—The Watsontown Door & Sash Co., plans the construction of a municipal electric generating plant in connection with its factory. Estimated cost $50,000.

**R. I., Pawtucket**—The Bd. Educ. will soon receive bids for the construction of a 3 story manual training and industrial arts high school, including steam heating and ventilating systems, on Fountain St. Estimated cost $1,200,000. R. C. N. Monahan, 255 Main St., Archt. Noted Oct. 11, 1921.

**Tex., Austin** — The Hotel Organization Com., J. B. Pope, Gen'l. Chn., Littlefield Bldg., plans the construction of a hotel. Estimated cost $800,000. Site not selected.

**Tex., McLean** — The Attorney General's Dept., Austin, approved bond issues voted; $30,000 for proposed light and power system, and $39,000 for waterworks improvements, here. Noted July 4.

**Wash., Pasco**—The Burbank Irrigation Dist., plans irrigation project in Franklin and Walla Counties of 22,000 acres, including construction of a wing dam at Strawberry Island, locks for navigation on the Snake River and power plant. Estimated cost $1,300,000. War Dept. may pay $700,000 toward cost of locks. Engineer not appointed.

**W. Va., Charleston**—Cass Gilbert, Archt., 244 Madison Ave., New York, is preparing plans for the construction of a 14 story 410 room hotel on Capitol Sq., here. Estimated cost $2,000,000. Owner's name withheld.

**W. Va., Huntington**—The U. S. Engineers Office will receive bids until Dec. 30 for the construction of a power house at Dam No. 30 on the Ohio River.

**W. Va., Logan** — The Logan Ice Co. is having plans prepared for remodeling present plant and the construction of a 22 x 100 ft. addition. A. C. Bishop, 427 Guardian Bldg., Cleveland, O., Engr.

**Wis., Appleton** — The Eagle Lodge, A. Schlitz, Pres., 775 Washington St., is having plans prepared for a new steam heating plant, in connection with its lodge building; will also install boilers. Estimated cost $25,000. E. A. Wettengell, 578 Pierce Ave., Engr.

**Wis., Hustisford**—J. Hurley, Hartland, plans the construction of a 2 story, 75 x 150 ft. creamery and dairy. Estimated cost $50,000. Architect not selected. Dairy and power machinery will be installed.

**Wis., Menasha**—The city plans to install automatic electric driven sewage pumping equipment, including two 20 lb. motors, automatic control panel, air compressors and connections. A. E. McMahon, City Engr.

**B. C., Point Grey** — The University of British Columbia, Vancouver, voted $1,000,000 for the construction of a group of buildings, a power house will probably be included, also completion of science building. Sharp & Thompson, London Bldg., Vancouver, Archts.

**N. B., St. John**—The city council passed a motion to have plans and specifications prepared for the construction of pole lines and underground duct system for an electric distribution system. Estimated cost $600,000. C. F. Fisher, Mayor. Noted July 4.

**Ont., Atwood**—The Atwood Lighting Co., J. G. Dickson, Pres., plans to install an electric lighting system. Prices and information wanted regarding equipment.

**Ont., Dundas**—The city council plans repairs to equipment at transformer station, damaged by short circuiting. Estimated cost $35,000. E. I. Sifton, City Hall, Hamilton, Engr.

**Ont., Ford**—The Ford Motor Co. of Canada is having plans prepared for the construction of a 1 and 2 story, 570 x 1,088 ft. and 65 x 1,088 ft. machine shop in connection with its automobile factory, here. Power and lighting equipment, including 6 transformers, 6 generators, motors, etc., will be installed. A. Kahn, 1000 Marquette Bldg., Detroit, Mich., Archt.

**Ont., Hamilton**—The Bd. of Control, G. S. Coppley, Chn., City Hall, plans the construction of a Collegiate Institute. Estimated cost $500,000. Tenders to be called in the spring. Prices wanted on equipment and materials.

**Ont., Niagara Falls**—The Ontario Hydro Power Comn., Sir Adam Beck, Chn. London, have plans under consideration for the construction of an auxiliary hydro-electric line from here to St. Thomas.

**Que., Montreal**—The Montreal Hardwood Flooring & Lumber Co., Ltd., Ontario and Parthenais Sts., is in the market for 80 hp. boiler for heating purposes.

## CONTRACTS AWARDED

**Ga., Atlanta**—M. Rich & Bros., 52 Whitehall St., awarded the contract for the construction of a 6 story, 177 x 199 ft. store on Alabama, Broad and Forsyth Sts. to the Selden Breck Constr. Co., Healy Bldg., $1,250,000. Equipment detail not reported.

**Ill., Chicago**—Kendall & Lund Amusement Co., c/o Leo Steif & Co., Archts., 64 West Randolph St., awarded the contract for the construction of a 6 story, hotel, store and dance hall building on 64th and Cottage Grove Sts., to F. A. Siebold Jr., 3130 Sheffield St., $1,200,000. Equipment detail not reported. Noted June 27.

**Mass., Boston**—Handschumacher & Co., Inc., 44 North St., awarded the contract for a 3 story addition to packing plant, to the Scully Co., 118 1st St., Cambridge. Estimated cost $125,000. Owner is in the market for packing plant equipment.

**Mass., Brighton** (Boston P. O.)—Silverman, Brown & Heenan, Archts., 51 Cornhill, Boston, will build by day labor, a 6 story 70 x 200 ft. store and apartment building on Allston St. Estimated cost $550,000. Steam heating system will be installed.

**Mass., Fall River**—The Standard Oil Co., 26 Bway., New York, awarded the contract for the construction of an oil plant, including a 61 x 83 ft. garage, 20 x 20 ft. pump house, 30 x 51 ft. warehouse, storage tank, etc., on Slade St., here, to the S. C. Sperry Co., 300 Main St., Cambridge. Estimated cost $50,000.

**Mich., Detroit** — The Bd. Educ., 1354 Bway. Ave., awarded the contracts for the construction of a 2 story, 58 x 183 ft. and 67 x 181 ft. school, including steam heating boiler and equipment, plenum system and mechanical ventilators, on Duboise and Waterloo Aves., to F. N. Cooper, 6370 Gratiot Ave., $321,104; also a 2 story, 171 x 191 ft. school, including steam heating boilers, and plenum system, on Palmer Ave., to the Martin-Krausmann Co., 606 Woodward Ave., $403,500. Noted Nov. 28.

**Mich., Jackson**—The Riverside Machine Co., G. H. Wilkins, Secy., awarded the contract for the construction of a 1 story, 50 x 150 ft. power house and additions to plant to the Union Iron Works; other additions to The Austin Co., 208 South LaSalle St., Chicago.

**Minn., Glen Lake** (Hopkins P. O.)—The Hennepin County Sanatorium Comrs., E. S. Mariatte, Secy., Hopkins, R. D., awarded the contract for the construction of a 45 x 108 ft. power house, to Pehrson Bros., 555 Temple Court, Minneapolis $229,500. Noted Nov. 21.

**N. Y., Buffalo**—The Island Warehouse Co., Ganson St., awarded the contract for the construction of a 10 story, 100 x 268 ft. flour mill, to the Fegles Constr. Co., 706 1st Ave., Minneapolis, Minn. Estimated cost $500,000. Equipment detail not reported. Noted Nov. 28.

**N. Y., New York**—The Bricken Realty Import Co., c/o Gronenberg & Leuchtag, 450 4th Ave., Archts. and Engrs., will build an 11 story, 85 x 95 ft. apartment building on Lexington Ave., by separate contracts, under supervision of architects. Estimated cost $500,000. Equipment detail not reported.

**Ohio, Cleveland**—The city awarded the contract for furnishing and erecting structural steel for the Fairmount Pumping Station, to the Forest City Steel & Iron Co., 1500 West 110th St., $135,037. Noted Nov. 7.

**Ohio, Toledo**—The Chevrolet Motor Co., General Motors Bldg., Detroit, Mich., awarded the contract for the construction of a 1 story, 91 x 450 ft. auto transmissions plant, including steam heating boilers and accessories in power plant, to H. J. Speaker, Toledo, Ohio. Estimated cost $225,000. Noted Nov. 21.

**Tenn., Memphis**—The Tri-States Hotel Co., awarded the contract for heating, vapor with high pressure boilers and ventilation, in connection with proposed 15 story, 358 room hotel on North Main and Adams St., to the Hughes Heating Co., 248 Court Ave., $55,000. Noted Oct. 31.

**W. Va., Clarksburg**—The Clarksburg Ice & Storage Co. will build a 1 story, 50 x 120 ft. ice plant. Estimated cost $50,000. Equipment detail not reported. Noted Oct. 17.

**Wis., Madison**—The J. Heilpren Fruit Co., J. Heilpren, Pres., West Mifflin St., awarded the contract for the construction of a 2 story, 75 x 150 ft. cold storage warehouse on Bedford St., to F. A. Tough, Archt., Conklin Bldg. Estimated cost $90,000. Equipment detail not reported. Noted Nov. 21.

**Wis., Waupaca**—The city, F. A. Houseman, Clk., awarded the contract for the construction of an emergency pumping unit, including centrifugal pump and motors, to the Hayton Pump & Blower Co., 575 2nd Ave., Appleton. Noted Nov. 7.